The Engineer

LONDON, FRIDAY, DECEMBER 12, 1941

PUBLIC NOTICES

SUDAN GOVERNMENT

APPOINTMENT OF TWO DISTRICT LOCOMOTIVE SUPERINTENDENTS

Sudan Railways Require the SERVICES of TWO DISTRICT LOCOMOTIVE SUPERINTENDENTS, age 25-33 ars, preferably unmarried. Candidates must fully qualified Locomotive Engineers, both in eory and in practice. Must have graduated in echanical Engineering from a University and/or ust be Corporate Members of the Institution of vil Engineers or of the Institution of Mechanical Engineers, must have served an apprenticeip or pupilage of not less than four years on a ilway or with a firm of locomotive builders of ute and must have filled a position of sponsibility on Locomotive Engineering for not s than one year.

Starting rate of pay £E480-540 per annum £1 equals £1 0s. 6d.), according to age, qualifitions and experience, with periodical increases pay in accordance with Government Scales, £E480-540-600-660-720-780-852-936, all increases being biennial with the exception of the st one, which is triennial.

Selected candidates will be appointed on proationary contract for two years and subscribe the Provident Fund, after which if accepted, serve, towards pension, their contributions ll be transferred to the Pension Fund. Free ssage on appointment. Strict medical amination.

Applications, giving full particulars as regards qualifications and experience, should be sent the SECRETARY, MINISTRY OF LABOUR ND NATIONAL SERVICE (Central Register anch), Queen Anne's Chambers, London, W.1, quoting reference O.N. C665. 8015

UNIVERSITY OF LEEDS

APPOINTMENT OF LECTURER IN CIVIL AND MECHANICAL ENGINEERING DEPARTMENT

Applications are Invited for the POST of LECTURER in the epartment of Civil and Mechanical Engineering. andidates must be Graduates in Engineering, ith special qualifications in Mechanical Engineering. Preference will be given to a candidate ho has both academic and practical experience. he Lectureship is in Grade IIB, with a salary ale of £345, rising by £15 annually to £420 a ar.—Applications should be addressed to the EGISTRAR, The University, Leeds, 2, and ould reach him on or before the 29th ovember. 8023

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are Invited for APPOINTMENT as ASSISTANT ECTURER in MECHANICAL ENGINEERING. pplicants should possess a good Honours Degree ld have had a good general training in Mechnical Engineering.

Salary according to the Burnham Award, hich, in the case of graduates, is up to £523 r annum. Commencing salary according to ualifications and experience.

Further particulars of the appointment and rms of application may be obtained from the irector of Education, Town Hall, Bradford, and ompleted forms should be returned to the rincipal of the College not later than 19th ecember, 1941.

THOS. BOYCE,
Director of Education.

5.12.41. 8017

SITUATIONS OPEN

OPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

O ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors re prepared to insert brief notices that vacancies re filled, upon receipt of notifications from the dvertisers. These notices (limited to one line) ill be free of charge, and co-operation is sked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

RESTRICTION ON ENGAGEMENT ORDER

WANTED, Thoroughly Competent HEAD of WAGES DEPARTMENT for a large works the West Riding.—Address, stating age, experience and salary expected, 8005, The Engineer ffice. 8005 A

The Engineer

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BABCOCK & WILCOX LTD.

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THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

SITUATIONS OPEN

WANTED, ENGINEER Above Military Age with Machine Tool experience for Sales Office in the Birmingham area. Good salary to suitable man.—Address, 8003, The Engineer Office. 8003 A

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THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

SITUATIONS WANTED

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
PRESS-NOON WEDNESDAYS

The Engineer

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(including postal charges)

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UNITED STATES OF AMERICA	NEW YORK: International News Co., 131, Varick Street, New York, N.Y., and all Branches Moore Cottrell Subscription Agency, North Cohocton BOSTON: F. W. Faxon and Co., 63–69, Francis Street

Entered as second-class matter at the Post Office, New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 307, P.L. & R.).

U.S.S.R.	LENINGRAD: Meshdunarodnaja Kniga, Prospect Volodarsky, 53A MOSCOW: Kuznetski Most 18

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"THE METALLURGIST"

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next due, December 26th.

ADVERTISEMENTS

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address, 28, Essex Street, Strand, London, W.C.2. Teleg. Address, "Engineer Newspaper, Estrand, London." Tel., Central 6565 (10 lines).

SITUATIONS WANTED

CHIEF ENGINEER (42) of Large Concern DESIRES CHANGE. General engineering experience, organiser, disciplinarian, push good contacts, exceptional references. Release arranged.—Address, P3707, The Engineer Office. P3707 B

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IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 4s.; each Additional Line, 1s.; Box Numbers, 6d. extra, which includes despatch of all replies.

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For continuation of Small Advertisements see page 64

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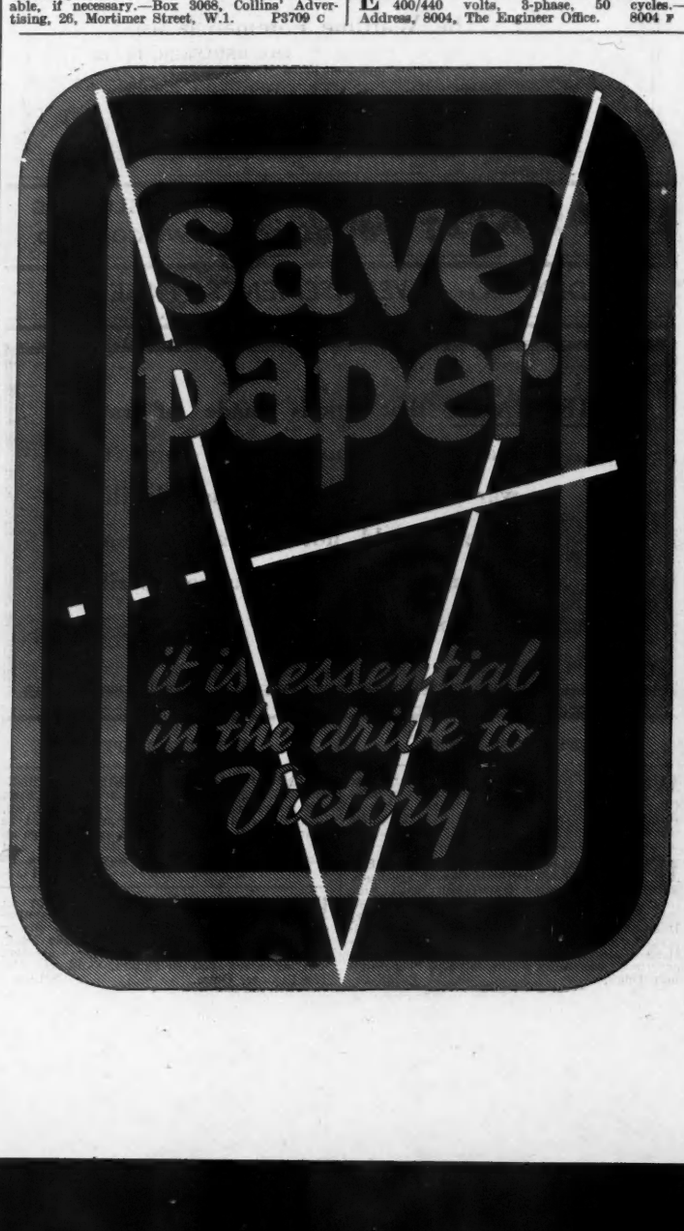

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A Seven-Day Journal

Japan Enters the War

ON Sunday, December 7th, without any formal declaration of war, Japanese forces attacked American bases in the Pacific Ocean by sea and by air. It was later announced by the Japanese High Command that from dawn on Monday Japan was in a state of war with Great Britain and the United States in the Pacific Ocean and the Far East. At Shanghai early on Sunday morning, about 4.30 a.m., the "Idzumo," the Japanese flagship, opened fire on the British gunboat "Peterel," which was sunk, many casualties being sustained. Attacks by air were made on the American base at Pearl Harbour, where the Pacific American Fleet was based. The 29,000-ton battleship "Oklahoma," which was built in 1914, was set on fire. Other attacks were made on the American base of Guam, and on American Army and Navy bases in Manila. Later, the Japanese landed on Northern Luzon, the biggest island of the Philippines group. Further landings were made in Northern Malaya, and heavy fighting between British and Japanese Forces is proceeding in the neighbourhood of the aerodrome of Kota Bharu. The British base at Hong Kong has been attacked from the land and from the air, and is being stoutly defended. As we go to press we learn with deep regret from the announcement by the Prime Minister in the House of Commons, that the battleships "Repulse," built in 1916, and the "Prince of Wales," the flagship of the Far Eastern British Fleet, have been sunk.

British Standards Institution

AT a recent meeting of the Chemical Divisional Council of the B.S.I., Dr. E. F. Armstrong, F.R.S., who has been Chairman of the Divisional Council since its formation some ten years ago, retired from the chairmanship and Mr. Roger Duncalfe, President of the A.B.C.M., was appointed to succeed him. Dr. Armstrong has for some time desired to be relieved of the chairmanship, particularly as he is fully occupied at the present time as Chemical Adviser to the Ministry of Home Security. It was due to Dr. Armstrong that the chemical industry co-operated in the enlargement of the scope of the standards organisation to include, as it now does, the major industries of the country. The successful issue of the conference which took place between the B.E.S.A. representatives and those of the chemical industry was in large measure due to Dr. Armstrong's diplomatic handling of what was undoubtedly a matter fraught with many difficulties, and as Chairman of the Chemical Division he has been responsible for the successful development of national standardisation in the chemical field. He was Chairman of the B.S.I. in 1934 and 1937, and is Chairman of the Finance Committee of the Institution. The Institution is fortunate in having secured Mr. Roger Duncalfe, President of the Association of British Chemical Manufacturers, as Dr. Armstrong's successor. Mr. Duncalfe has for many years past been one of the leading men in the glue and gelatine industry.

Wages in the Engineering Trades

THE National Arbitration Tribunal, under the chairmanship of Mr. Justice Simonds, sat in London on Monday last, December 8th, to hear the claim presented by the Amalgamated Engineering Union and the National Union of Foundry Workers on behalf of 600,000 engineers for an advance in their basic wage rate of 4d. an hour or 15s. 8d. per week. In speaking for the men, Mr. J. Tanner, the President of the A.E.U., stated that the wage rates of fitters and turners in many districts were below £4 a week. Men, he claimed, could not live even in a moderate standard of comfort and their efficiency was impaired. In some cases excessive overtime was being worked in order to meet the present costs of living. Mr. Tanner said that he felt that the employers were depending on the White Paper on Stabilisation which had been repudiated by the whole trade union movement. The deduction of income tax had reduced many shipyard workers during the shorter winter weeks to sheer penury. In his reply for the Employers' Federation Sir Alexander Ramsay praised the splendid service of the workers. He denied that the employers were relying entirely on the White Paper, but said that that document was an important Government statement on war economy, which serious-minded people must take into account. He denied also that employers were getting excess profits out of the war. In rejecting the claim of the unions, the employers, he said, had not the slightest desire to come into conflict with their workpeople, but they felt that there were times when a responsible organisation had to face its responsibilities. Quoting the wage figures for the month of July, Sir Alexander said that over the whole range of engineering, shipbuilding and metal industries group the average wage was £5 11s., while in that section of the industry concerned with the construction of motor vehicles and aircraft the average ranged up to £6 7s. 5d. per week. The hearing was concluded and the Tribunal will issue its award in due course.

Payment by Results in the Building and Civil Engineering Industries

IN a Journal note of November 28th we referred to the decision of the Ministry of Works to appoint an official panel of both employers and operatives to advise it on all matters which in the future may arise out of the administration and working of an extended system of payment by results. It is now announced by Lord Reith, the Minister of Works, that this panel has been appointed. The members of the panel are as follows:—Mr. H. C. Harland, Mr. G. H. Parker and Mr. L. T. Wallis, appointed by the National Federation of Building Trade Employers; Mr. R. Coppock, Mr. L. Fawcett, Mr. J. W. Stephenson and Mr. B. Sandercock, appointed by the National Federation of Building Trade Operatives; Mr. G. M. Burt, Mr. A. M. Holbein and Mr. H. T. Holloway, appointed by the Federation of Civil Engineering Contractors; Mr. T. Pugh, Mr. H. Bullock with Mr. C. L. Skinner as alternative, appointed by the Civil Engineering Conciliation Board (Operatives); and Mr. G. T. W. Fairbrass, of Corderoy, Ltd., an independent quantity surveyor. It is intended to refer to this panel all questions raised from sites in regard to the scheme where any matter of policy or interpretation is involved. As a result of the decisions of the panel it is hoped to create in time a code that will be understood and will be operated throughout the country. The first meeting of the new panel took place on Thursday, November 27th.

Control of Factory and Storage Premises

IN these columns we have already recorded the decision of the Board of Trade to set up a Control of Factory and Storage Premises, and the appointment of Sir Cecil Weir as Controller-General of Factory and Storage Premises. On Wednesday, December 3rd, Sir Cecil gave an account of the work of his Department at a Board of Trade Conference. He said that the basic information on which the Department began its operations was obtained from returns which covered some 40,000 factories and storage premises and provided details of the buildings, the employees, the services and the work carried on. That information, Sir Cecil said, was tabulated and the appropriate sections were distributed to each of the twelve Civil Defence Regions in which a Regional Controller of Factory and Storage Premises was appointed. Since it was put into operation the Control had allocated nearly fifty million cubic feet of space, one-third for production and two-thirds for storage. Much of this space has been obtained through concentration of production in many industries, which was brought about by the application of the Board of Trade Limitation of Supplies Order and the Control of Raw Materials. With the development of the Government's economic policy of transferring resources to war industry, labour, materials and factory space were soon released for more essential purposes. In order to reduce to a minimum the expenditure of the national effort on building it was arranged that no Government Department should proceed with any new building programme for factories or stores until the Factory Control had certified after careful investigation that no suitable building already existed which would do instead.

The Reassembly of American Aircraft

BY the courtesy of the Ministry of Aircraft Production we were recently permitted to visit one of the North-Western Reassembly Divisions, where aircraft received from American manufacturers are reassembled, tested, and made ready for operational service in the short space of two to three weeks for a fighter and five to six weeks for a medium-sized bomber. The chain of operations from degreasing and cleaning, the fitting of electrical radio, and armament equipment to meet Service conditions was inspected, and the preparation for engine tests and final flying tests were demonstrated. Among the machines seen may be mentioned the Douglas D B 7 B Boston light bomber; the Lockheed Hudson reconnaissance bomber; the Bell Airacobra P 39 fighter; the P 40 D Kittyhawk fighter; and the North American N A 73 Mustang fighter. In a speech made at a luncheon following the visit, Mr. W. C. Deveraux, the Controller for North American Aircraft Supplies, described the progress which had been made in recent months in dealing expeditiously with these aircraft, which, more and more, he said, were being delivered almost ready for operational service. In addition to the many aircraft arriving in this country as deck cargoes or packed in cases, others were being ferried over, and Mr. Deveraux announced that a further west to east Atlantic record had been created last week by the arrival in this country of a Consolidated Liberator heavy bomber, which, piloted by Captain Cramer, an American pilot, had made the trip in 8 h. 20 min. In carrying out this important work of reassembly, the Ministry, said Mr. Deveraux, had received much valuable help from Mr. Henry H. Ogden.

Employment Returns

IT was announced on Tuesday evening, December 9th, by the Ministry of Labour and National Service that the number of men and boys registered at employment exchanges in Great Britain as wholly unemployed on November 17th was 95,335, a decrease of 1699 compared with October 13th. Of this total, 27,821 had been classified by interviewing panels as unsuitable for ordinary industrial employment. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 5914; this was a decrease of 706 compared with October 13th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 10,784, an increase of 1364 compared with October 13th. The corresponding figures for women and girls on November 17th were 76,649 wholly unemployed, 10,098 temporarily stopped, and 322 unemployed casual workers. Of those wholly unemployed, 3076 had been classified by interviewing panels as unsuitable for normal full-time employment, and 3311 had been classified as unable for good cause to transfer to another area. Compared with October 13th, the numbers wholly unemployed showed a decrease of 12,167, those temporarily stopped a decrease of 3734, and unemployed casual workers a decrease of 155.

Historic Accidents and Disasters

No. X

(*Continued from page 309, November 7th*)

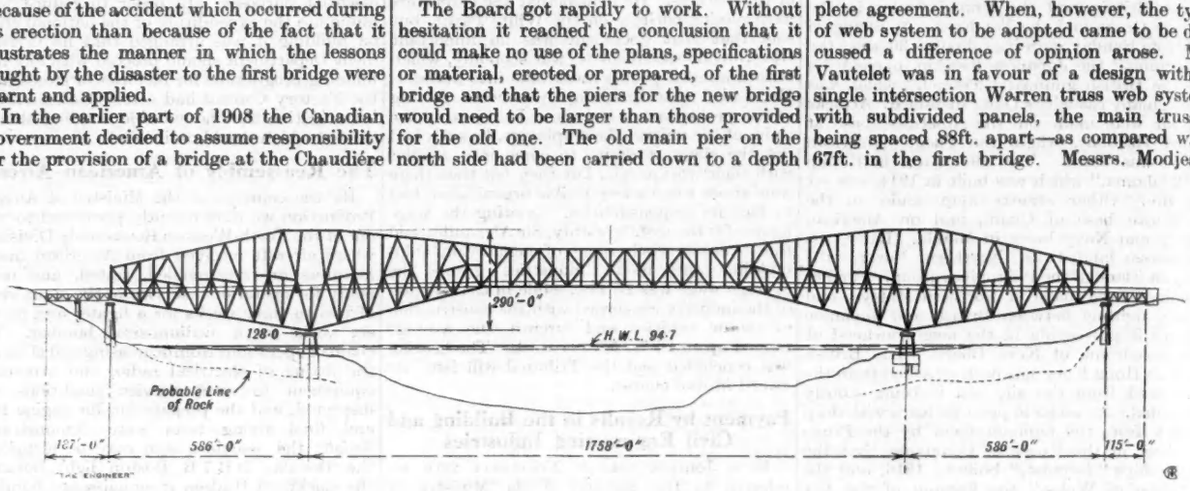
The Second Quebec Bridge

THE history of the second—the existing—Quebec bridge interests us to-day less because of the accident which occurred during its erection than because of the fact that it illustrates the manner in which the lessons taught by the disaster to the first bridge were learnt and applied.

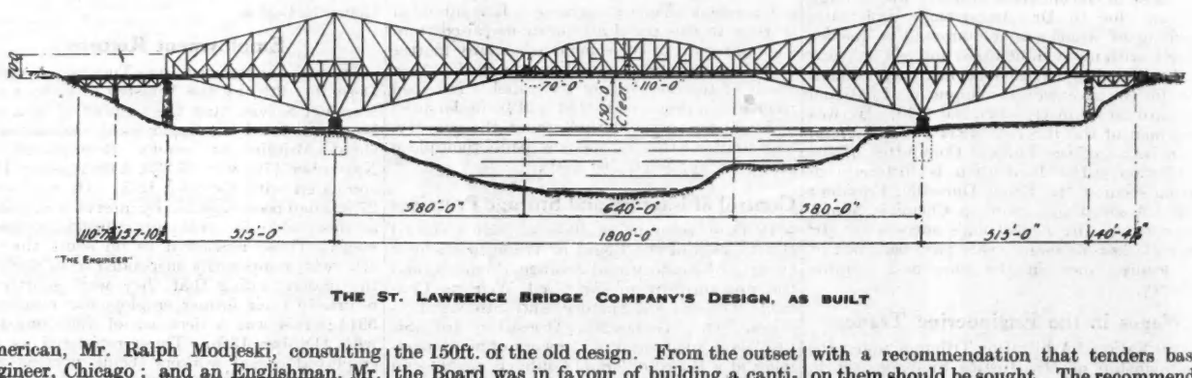
In the earlier part of 1908 the Canadian Government decided to assume responsibility for the provision of a bridge at the Chaudière site as a link in the Transcontinental Railway then under construction. In accordance with that policy an Order in Council was issued, authorising the Minister of Railways and Canals to take over the whole undertaking of the Quebec Bridge and Railway Company. It was further decided that the entire responsibility for the new undertaking should be placed in the hands of a special board consisting of three engineers acting under the Minister On August 17th, 1908, an Order was issued naming as members of this Board of Engineers a Canadian, Mr. H. E. Vautelet, consulting engineer, Montreal; an American, Mr. Ralph Modjeski, consulting engineer, Chicago; and an Englishman, Mr. Maurice Fitzmaurice, Chief Engineer of the London County Council. Mr. Vautelet was nominated Chairman of the Board and Chief Engineer. The Order laid it down that the Board was to examine the plans, specifications and material of the first bridge with a view to determining whether they could be re-used or modified. In the event of the Board reaching the conclusion that it was inexpedient to re-use the old plans it was to prepare a new design, specification and estimate of cost and submit them to the Department of Railways and Canals. Should a serious difference of opinion arise between the members of the Board it was to call in two eminent bridge engineers to help it to settle the questions at issue.

The Board got rapidly to work. Without hesitation it reached the conclusion that it could make no use of the plans, specifications or material, erected or prepared, of the first bridge and that the piers for the new bridge would need to be larger than those provided for the old one. The old main pier on the north side had been carried down to a depth of about 46ft. short of the bed rock. It was therefore decided that it should be scrapped and that an entirely new and enlarged pier should be built 57ft. farther out from the shore. On the south side it was thought that it would be possible to utilise the masonry of the old pier and to enlarge its area by adding 30ft. of fresh masonry on its south and west sides. The result of these changes would have been to reduce the main span from 1800ft. to 1758ft. Much thought was given to the question of the clearance to be provided beneath the main span, but eventually it was decided to allow it to remain at should be considerably increased. It considered the desirability of arranging the trusses in vertical planes converging from the main piers towards the ends of the cantilever and anchor arms or alternatively of copying the arrangement followed in the Forth bridge, in which the trusses not only converge longitudinally, but slope inwards vertically. Eventually it decided against both these arrangements and in favour of vertical and parallel trusses as adopted in the Phœnix Company's bridge.

So far the Board members were in complete agreement. When, however, the type of web system to be adopted came to be discussed a difference of opinion arose. Mr. Vautelet was in favour of a design with a single intersection Warren truss web system with subdivided panels, the main trusses being spaced 88ft. apart—as compared with 67ft. in the first bridge. Messrs. Modjeski and Fitzmaurice did not consider this design altogether desirable and outside assistance was sought in accordance with the instructions to the Board. Mr. Paul Wolfel, chief engineer of the McClintic-Marshall Company, and Mr. Phelps Johnson, president of the Dominion Bridge Company, were called in to consult with the Board and at a meeting held in September, 1909, a majority view in favour of a double intersection design was expressed. Nevertheless, complete working drawings of Mr. Vautelet's design were prepared and in May, 1910, they were sent to the Government as the "Board's design" with a recommendation that tenders based on them should be sought. The recommendation added that in the event of a better design being submitted by any of the bidders it should be adopted. In October, 1910, tenders were received from the St. Lawrence Bridge Company, the Pennsylvania Steel Company, the Maschinenfabrik Augsburg-Nürnberg and the British Empire Bridge Company. Before they were received—in June, 1910—Mr. Fitzmaurice resigned from the Board and was succeeded by Mr. Charles Macdonald, a Past President of the American Society of Civil Engineers. On November 3rd, 1910, Messrs. Macdonald and Modjeski

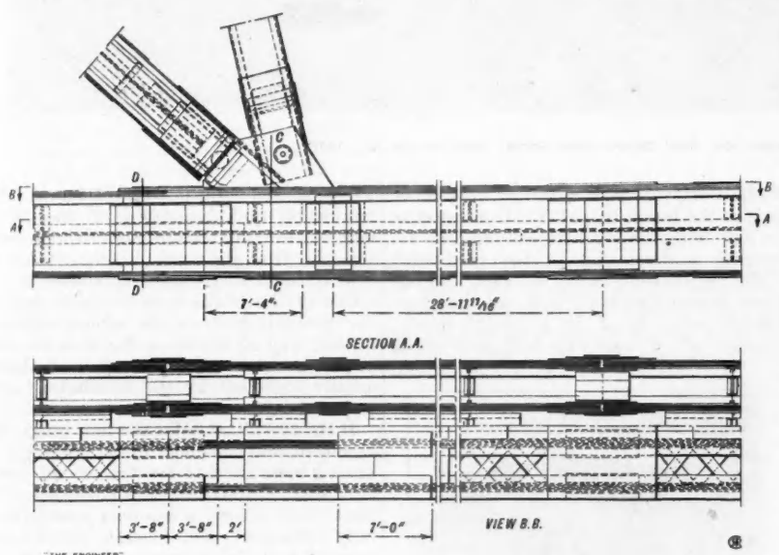


THE BOARD OF ENGINEERS' DESIGN



THE ST. LAWRENCE BRIDGE COMPANY'S DESIGN, AS BUILT

submitted a report to the Minister in which they recommended that the tender of the St. Lawrence Bridge Company for a design which it itself had prepared should be accepted. Mr. Vautelet dissented and recommended the acceptance of a tender based on the "Board's design." In view of this difference of opinion the Minister appointed Mr. M. J. Butler, former Chief Engineer of the Department of Railways and Canals, and Mr. H. W. Hodge, consulting engineer, New York, to act as consulting engineers to the Board. These gentlemen confirmed the recommendation of Messrs. Macdonald and Modjeski in favour of the St. Lawrence Company's design and on April 4th, 1911, the Government accepted that company's tender. During this stage in the history of the initial proceedings Mr. Vautelet resigned from the Board, and as soon as the contract was signed Mr. Macdonald, in accordance with a previous undertaking, also retired from his office. On May 6th Mr. C. N. Monsarrat, engineer of bridges, Canadian Pacific Railway, was appointed to succeed Mr. Vautelet as Chairman and Chief Engineer of the Board, and on



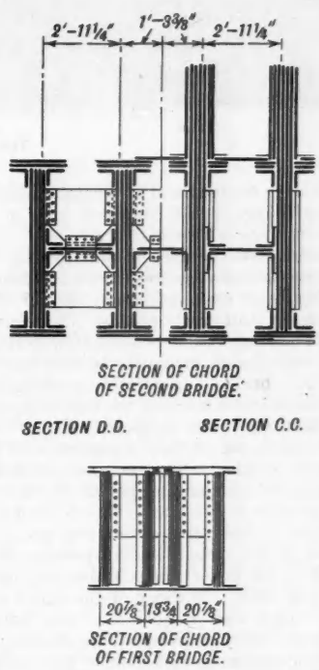
TYPICAL CHORD SECTION OF NEW BRIDGE

May 17th Mr. C. C. Schneider, a Past-President of the American Society of Civil Engineers, was appointed to take Mr. Macdonald's place. The Board as thus constituted remained in being without further change until Mr. Schneider's death in January, 1916. To fill the vacancy thus created Mr. H. P. Borden, a civil engineer, of Montreal, who had been an assistant engineer on the Board's staff since 1908, was appointed the third member of the Board.

All told, eleven different engineers were in this way members, permanently or temporarily, of the Board charged with the responsibility of constructing the new bridge. In this respect the contrast with the circumstances in which the first bridge was built is striking, for in that case responsibility was virtually concentrated in the hands of one man, Mr. Theodore Cooper. In another respect, however, the histories of the two bridges are similar. In both cases the bridge was designed, not by the responsible Board or civil engineer, but by the contractors for its erection. This factor was, and still is, unusual in the construction of large bridges, even in America. To it some of the factors entering into the failure of the first Quebec bridge may legitimately be traced. That the same plan was followed in the case of the second bridge may seem curious. It implies a very generous admission on the part of the Board—or of the majority of its members—that the contractors' design was a better one than its own. In the event the procedure was fully justified. Except for the accident which occurred during the raising of the suspended span, the design, fabrication and erection of the bridge proceeded smoothly and satisfactorily. Much of the success attending the work is undoubtedly to be attributed to the skill of the St. Lawrence Bridge Company's designers and the fine workmanship of its engineers. Much, too, must also be attributed to the remarkable degree of co-operation which existed throughout between the contractors and the Board and the very active supervision over all stages of the work exercised by the Board.

The St. Lawrence Bridge Company was an undertaking incorporated in the joint interests of the Dominion Bridge Company, of Lachine, and the Canadian Bridge Company, of Walkerville, with a view to combining the organisations and resources of those two companies for the special purpose of executing the Quebec bridge contract. It submitted tenders for the "Board's design" and also for seven designs of its own, some of which differed merely as regarded the material to be used—such as nickel steel instead of carbon steel. The design on which it was awarded the contract was for a bridge with a main span of 1758ft., carrying two railway tracks, two roadways and two sidewalks. Its outstanding feature was the nature of its web system. This system, which came to be known as the K system, had never before been proposed for an important structure. The Board, however, came to the conclusion that it possessed all the advantages of a double intersection system without its disadvantages. It gave high credit to the engineers of the St. Lawrence Bridge Company for having grasped the advantages of this type of truss and applying it to the construction and erection of a bridge of the size contemplated. The advantages of the K system are now thoroughly well recognised. In the first place it facilitates erection in so far that each main and sub-panel is entirely self-supporting and can be fully erected by the traveller as the work progresses without the use of a large amount of temporary erection struts and tackle. Secondly, it results in a reduced length of the individual members of the web system and permits a more gradual variation in the section of the bottom chords. Thirdly, the secondary stresses are small; and fourthly, at all stages of the erection and subsequently after completion the stresses in all the members are completely determinate.

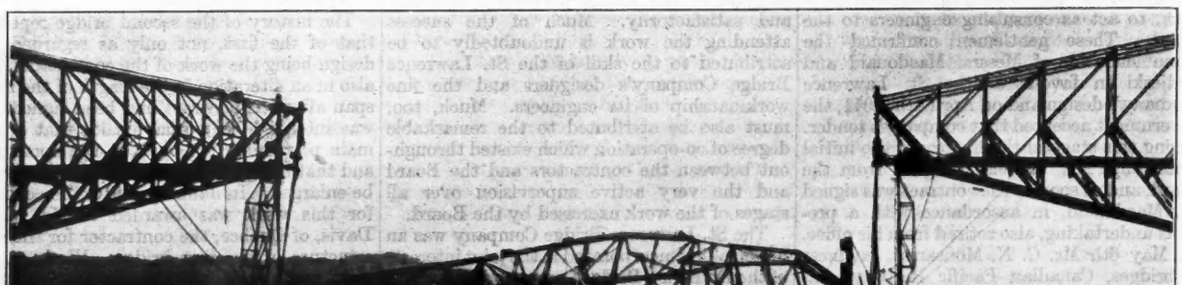
The history of the second bridge repeated that of the first, not only as regarded the design being the work of the contractors, but also in an alteration in the length of the main span after the contract had been signed. It was intended, as we have said, that a new main pier should be built on the north side and that the old pier on the south side should be enlarged. In January, 1910, the contract for this work was awarded to Mr. M. P. Davis, of Quebec, the contractor for the substructure of the first bridge. Work on the new north pier was begun at once, the enlargement of the south pier being postponed until the wreckage of the old bridge had been cleared away. The contract for



CROSS-SECTIONS OF CHORDS

the removal of the wreckage was awarded to Charles Koenig and Co., of Quebec, and the work occupied the best part of two years. For the construction of the north pier a very large caisson, measuring 180ft. by 55ft., was built and towed to the site. Very great care had to be exercised in handling it, but in spite of all precautions an accident occurred to it in August, 1910, which strained it to such an extent that it was impossible to maintain the air pressure in the working chamber. The caisson had to be towed back to the dry dock and repaired. As a result of this mishap the design of the caisson for the south pier was reconsidered and the conclusion was reached that the plan of enlarging that pier would entail considerable risk. In March, 1911, it was decided to abandon that plan and to build an entirely new pier on the south side. The intended position of the north pier was slightly altered at the same time. The site for each of the new piers was fixed at 65ft. south of the corresponding old

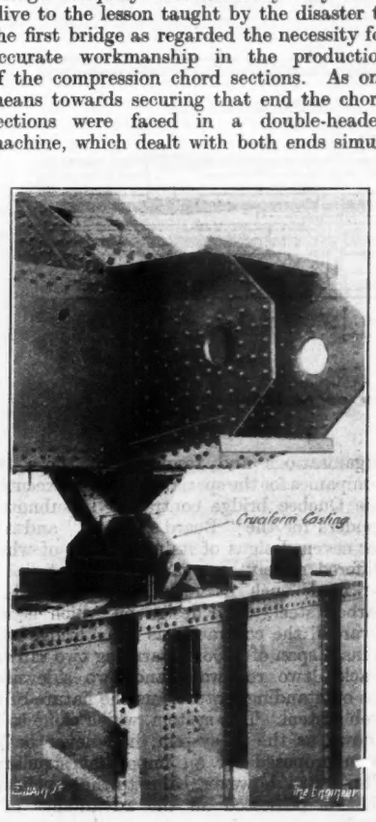
piers. In this way the main span of the bridge was changed from the 1758ft. of the contract design and restored to the 1800ft. of the old bridge. The St. Lawrence Bridge Company prepared a new design, which retained, however, the essential features of that on which it was awarded the contract. For reasons of economy, however, the two roadways for which provision was originally made were omitted and as a consequence the bridge to-day carries only two lines of railway and two sidewalks.



THE COLLAPSE OF THE SUSPENDED SPAN, SEPTEMBER 11, 1916

Among the details of the design chief interest naturally centres on the construction of the lower or compression chords of the cantilever and anchor arms, the elements which by their weakness and faulty workmanship contributed primarily to the failure of the first bridge. Generally speaking these chords resemble those of the first bridge in so far that they are composed of four webs, each consisting of four thicknesses of plate riveted together. The sectional area of the chords at comparable points is, however, about twice as great as in the old bridge. In addition, important differences are to be found in the design and disposition of the diaphragms, cover plates and lacing uniting the four webs. Midway of the chord depth each outer web is joined to the adjacent inner web by a longitudinal diaphragm plate, so that in section each pair of webs appears like a letter H. A similar diaphragm plate unites the two inner webs. At intervals above and below the longitudinal diaphragms transverse diaphragms are riveted to them and to the web faces. In the chords of the first bridge there were no longitudinal diaphragms, while the transverse diaphragms occupied only the upper half of the chord section. At the splices cover plates are riveted across the upper and lower faces of the chords. Between these cover plates the webs are united in pairs by diagonal lattice bars. In the old bridge the diagonal lacing consisted of angle sections extending across all four sections and formed one of the weakest features of the design. Another noteworthy difference is to be found in the means of connecting the compression chords to the diagonal and vertical members of the truss system. In the first bridge the connection was made by means of a pin passing through a reinforced portion of the webs. In the second bridge the pins pass through gusset plates attached to and extending upwards from the webs. The lengths of the individual sections of the chords, measured from splice to splice, are less in the new bridge than they were in the old, being about 40ft. to 45ft., as compared with nearly 60ft. This reduction of length facilitated handling and promoted accuracy of production. In addition, the fact that all the sections are straight instead of being bent, as in the first bridge, simplified the accurate machining of the abutting ends.

Both the Board and the St. Lawrence Bridge Company were naturally very much alive to the lesson taught by the disaster to the first bridge as regarded the necessity for accurate workmanship in the production of the compression chord sections. As one means towards securing that end the chord sections were faced in a double-headed machine, which dealt with both ends simultaneously. Thereby the builders avoided the slight, but vital, difference in the lengths of the webs suspected to have occurred in the first bridge as a result of the sections racking while being turned end for end in the shops during the end facing operations.



CRUCIFORM CASTING AND LIFTING GIRDER

In general the St. Lawrence Bridge Company's shop work was of a very high-class order. The works of the two parent companies were inadequate for the purpose of fabricating the parts of the bridge without a prohibitive amount of reconstruction and re-equipment. Accordingly new works were built and equipped at Rockfield, near Lachine, at a cost of over one million dollars. During the fabrication of the parts of the Quebec bridge no other bridge or constructional work was permitted in the new establishment. The fabrication and inspection of the bridge members in the contractors' shops went smoothly from the start. To the attainment of that result much was contributed by the action of the works manager, who early in the proceedings took the almost unprecedented step of investing the Board's chief inspector with the additional authority usually exercised by the contractors' shop inspectors.

If the specification for the first bridge was an incomplete document drawn up in a haphazard manner, that for the second bridge may well be described as a model specification, which before it was finally settled was fully discussed in all its details with the contractors and the suppliers of the material. Once settled, it was strictly interpreted and its provisions were insisted upon in all respects. Comparing the requirements of the two specifications as regards the strength and the stressing of the material, we find less difference than might be expected. For the second bridge the carbon steel employed was required to have an ultimate strength in tension of 62,000 lb. to 70,000 lb. and a minimum yield point of 35,000 lb. per square inch. These figures are identical with, or very nearly so, those specified for—but not realised in—the first bridge. The maximum permissible working stress for riveted tension members was 18,000 lb. or, including secondary stresses, 24,000 lb. For members in compression the maximum permissible stress was 14,000 lb. or 18,000 lb. including secondary stresses. In the first bridge an extreme stress of 24,000 lb. was permitted in both tension and compression members and in practice was exceeded. Considerable use was made of nickel steel in the second bridge. For this material an ultimate strength of 85,000 lb. to 100,000 lb. with a yield point of 50,000 lb. was specified. Maximum working stresses for it 40 per cent. greater than those for the carbon steel were permitted.

In no respect is the contrast between the conditions under which the two bridges were erected greater than in the supervision of the

responsible engineers over the designing work of the contractors. In the case of the first bridge that supervision was defective even to the extent of failing to detect large errors in the weights and stressing of the members. In the case of the second bridge the Board of Engineers meticulously examined every detail of the contractors' designs and calculations. It employed an efficient staff of engineers, calculators and draughtsmen, who prepared stress sheets for the structure entirely independently of the contractors' staff and often by independent methods. All assumptions and empirical formulæ were traced back and none was admitted which could not be fully supported by experiment or be otherwise verified. The Board's work was carried out entirely as it would have been if, instead of being merely for checking purposes, it had been the only work intended to ensure the safety of the bridge. When points of difference arose between the Board's and the contractors' calculations the disagreement was investigated and satisfaction was not found until full harmony was attained. By this process a feeling of extreme confidence was developed in the minds both of the Board and the contractors.

The history of the second Quebec bridge is not a story of a disaster, but of a fully merited success. From the start of the operations everything conceivable was done to command success and when the accident to the suspended span occurred on September 11th, 1916, all concerned felt so sure that success was deserved that no one hesitated about completing the bridge in the manner originally planned. In the case of the first bridge the method of erecting the suspended span consisted of cantilevering one half of it out from the end of each cantilever arm. For the second bridge the plan adopted consisted of erecting the span as a complete unit at Sillery, some 3 miles below the bridge site, supporting it on six pontoons, towing it up river and hoisting it into place by means of hydraulically operated lifting tackle.

On September 11th, 1916, the span was floated out on its pontoons at 3.40 a.m. and an hour later it began its journey to the site. At 6.35 a.m. it reached the bridge and at 7.40 a.m. the lifting hangers at the four corners had been connected. At 8.50 a.m. the jacks began lifting and during the third lift of 2ft. the pontoons floated clear, leaving the span suspended about 20ft. above the river surface. After another lift of 2ft. work was stopped for a rest period. Up to this point everything had gone exactly as foreseen and it was considered that the most difficult part of the work had been accomplished. At 10.30 a.m. jacking operations were resumed and another lift was made. At 10.50 a.m., while the jacks were being lowered for another lift, a sharp report was heard and the span was seen to slide off its end supports into the river. Thirteen men were killed and fourteen injured, the majority of the casualties occurring among those actually on the span at the time of the mishap.

The span as prepared for lifting weighed over 5000 tons. It was supported during erection and lifting on a lifting girder at each corner, to which the lifting bars extending upwards to the jacking equipment at the ends of the cantilever arm were connected. Between the corners of the span and the lifting girders the weight was transmitted through cruciform castings, each of which worked in conjunction with two pins lying at right angles and constituting a universal joint. Investigation showed quite clearly that the cruciform casting at the south-west corner of the span had failed and had allowed the corner of the span to drop on to the lifting girder. The blow kicked the girder backwards with the result that the span was left hanging by three of its corners. The bracing was quite insufficient to allow the span to withstand this uneven loading. It failed, the chords buckled, the south-east corner slipped off its girder and finally the span was pulled off the girders at the north-west and north-east corners. Why the casting at the south-west corner failed was not discovered. A curious fact connected with it was that for over six weeks, while the span was at Sillery, the casting had been subjected to a load 10 per cent. greater than the load which it carried during the lifting operations.

When the weight of the suspended span was first transferred to the cantilever arms the ends of those arms deflected by about 7½in. The sudden release of the load when the span fell caused the arms to spring violently upwards and set up a severe vibration and oscillation. After the mishap the whole of the structure was very thoroughly examined, but no injury or distortion was discovered.

The St. Lawrence Bridge Company accepted responsibility for the accident and undertook to replace the span. Both the Board and the contractors retained full confidence in the design of the suspended span and in the general scheme for lifting it into position. A few quite minor alterations were made in the design and in the lifting arrangements, the most notable being the substitution of a lead cushion for the second pin in the cruciform castings.

Although the contractors' shops had by the time of the accident been largely turned over to the manufacture of shells and a considerable proportion of their bridge building equipment had been dispersed, it was found possible to begin erection of the new span at Sillery on June 4th, 1917. By August 27th the erection was completed and on September 17th, the weather and tide being suitable, the span was floated and towed to the site. The lifting operations covering seventy-five separate lifts were completed in four days. On September 20th the final pins connecting the permanent suspension bars to the span were driven. On October 17th the first train crossed the bridge and on August 21st, 1918, the bridge was finally completed and accepted by the Government.

A Century of Tunnelling*

No. III

(*Continued from page 391, December 5th*)

Sub-aqueous Tunnels

BY sub-aqueous tunnels I refer to those driven under rivers, harbours, or estuaries If there is a considerable depth of cover and the soil is impermeable, as in the case of the Tower subway, then little difficulty occurs. But with permeable soil and thin cover the case is very different.

The first sub-aqueous tunnel to be constructed was Brunel's Thames tunnel, already

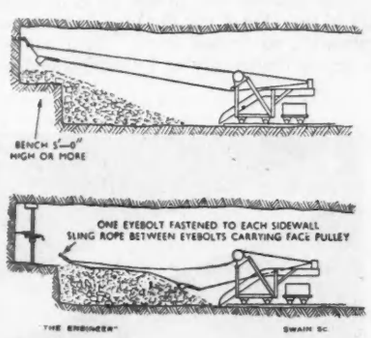

BENCH 5'-0" HIGH OR MORE
ONE EYEBOLT FASTENED TO EACH SIDEWALL
SLING ROPE BETWEEN EYEBOLTS CARRYING FACE PULLEY
"THE ENGINEER"
SWAIN Sc.

FIG. 12—*Diagram of Scraper Loader*

referred to, and here the conditions were particularly unfavourable. His experiences give a measure of the troubles that may be encountered in the absence of adequate provision to hold back the water. In tunnelling under a river where there is only a thin cover through which the water is liable to leak or even to break through, the inflow can be checked to a considerable extent by depositing a thick blanket of clay in the river bed. This was done on the Thames tunnel, the Hudson River and several later tunnels. The lining is in all cases brought close up behind the excavation to reduce the area for leakage.

The most satisfactory method yet found of restraining the water is the use of compressed air. The difficulty lies in maintaining the pressure when the soil is porous and the cover slight. For sub-aqueous tunnelling under such conditions the use of a shield and compressed air is now the recognised standard practice.

In some cases it may be found possible to lower the level of the tunnel and get into impermeable soil, but often the permeable soil extends to such a depth that this is impracticable and the tunnel has to be kept

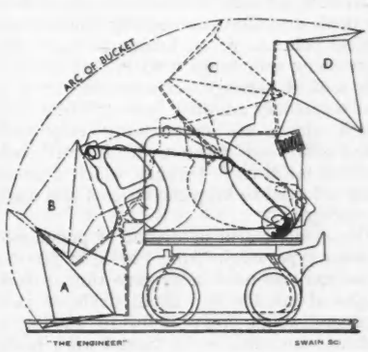


FIG. 13—*Diagram of Eimco-Finlay Loader*

at some higher level at which the air pressure required to restrain the water will not exceed the accepted safe limit. This in turn reduces the cover and increases the risk of blows. The clay blanket already referred to then becomes very effective and, indeed, some tunnels have been constructed which without its use would, it is considered, have been impracticable. Clay plugging of the face, as already described, is also another valuable device for reducing air loss. Chemical consolidation and grouting of the face have occasionally proved useful adjuncts in sub-aqueous tunnelling with compressed air.

* Institution of Mechanical Engineers, November 21st. The Twenty-eighth Thomas Hawksley Lecture, by W. T. Halcrow.—Abstract.

Rate of Progress in Sub-aqueous Tunnels.—The conditions under which sub-aqueous tunnels are driven vary so widely that it is difficult to generalise on the subject of speed. I may, however, cite a few figures for the average rate of advance :—

Sarnia tunnel	65ft. a week
Brooklyn tunnels	45–52ft. a week
Rotherhithe road tunnel ...	31ft. a week for the first half of its length and 59ft. a week for the second half

These and other instances indicate an average rate of 50–60ft. a week under reasonably good conditions. In mixed ground, where the top of the tunnel is in soft material and the lower part in rock, progress is considerably slower. In soft material much higher rates have been obtained. In the 29ft. diameter Holland tunnel under the Hudson River, where the material was silt, a rate of 112ft. a week was maintained in 1924.

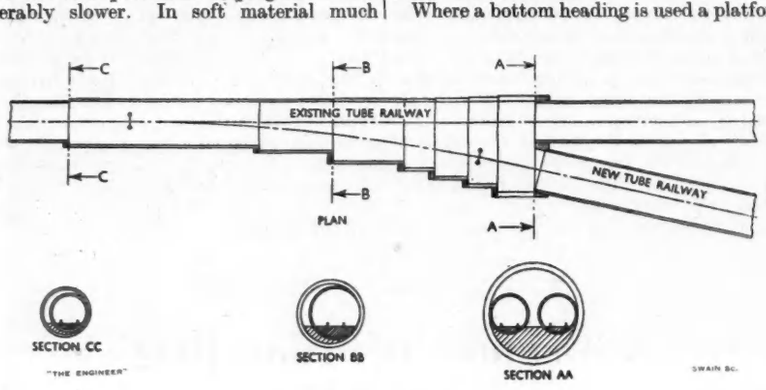


FIG. 14—*Diagram of Tunnel Junction*

GENERAL

Tunnel Excavation.—For rock excavation hand drilling is now superseded by power drilling ; the drilling machines used are generally of the piston and hammer types of percussion drills, usually the latter.

In the piston type the drill is attached to the piston of a reciprocating engine ; in the hammer type the drill is a separate unit and is driven by a hammer attached to the piston. The drills or drifters are usually mounted on vertical columns or on horizontal bars, the latter being sometimes used in combination with a drill carriage. Pneumatic drive is most commonly adopted, but hydraulic and electric drive are occasionally employed. Steam is now no longer used. In hard rock a hollow bit is used, through which a jet of water is forced to keep the bit cool and wash out the grit.

The modern drill or drifter of pneumatic hammer type weighs from 120 lb. to 220 lb.; a medium size used in average tunnel work weighs about 150 lb. Hand drills or jack hammers weigh from 30 lb. to 130 lb., a medium size suitable for tunnel work being about 60 lb.

The conditions of drilling vary so widely that it is difficult to give any figures of speed of drilling. The figures given in Table II show the rates of drilling, in feet per hour, of a hole 1⅛in. in diameter in soft to medium rock and in hard rock, by hand drilling, jack hammer and drifter. The rates may be taken as reasonable, under practical conditions, and give some indication of the relative speeds of machine and hand drilling.

TABLE II.—*Rates of Drilling*

The figures all refer to a hole 1⅛in. in diameter, and are given in feet per hour.

	Soft to medium rock.	Hard rock.
Hand drilling	1½–2½	¼–1
Jack hammer	10–20	5–10
Drifters	25–35	20–25

Removal of Spoil.—The methods for the removal of the spoil are generally applicable to all types of tunnel ; the operation may be divided into two parts : loading and haulage.

Loading comprises the clearing up of the excavated material at the working face and placing it in wagons or other receptacles for hauling out of the tunnel. Hand loading is still adopted on occasions, particularly in small tuunels. The work is facilitated if steel sheets are placed on the floor of the tunnel, on which the material can fall and whence it can be more easily shovelled than from the tunnel floor.

Where a bottom heading is used a platform is sometimes built at the level of the top of this heading, on to which the excavated material from the upper part of the tunnel falls ; from here it can be tipped into wagons running below.

In large tunnels mechanical loaders are generally employed. The type first used resembled a small steam shovel, but was operated by compressed air instead of steam. It was satisfactory, but it required a lot of room and was only suitable for very large tunnels. By reducing the height of the machine and the size of the jib a modified form of this shovel was developed for special application to tunnel work. Such shovels are driven electrically or by compressed air and they are made for a full-circle or part-circle turn.

Another type of loader is the scraper loader ; this consists of a bottomless scraper pulled by a cable in somewhat similar manner to a dragline excavator. The spoil is scraped on to a hinged steel chute or apron which can be tipped to discharge into wagons below. Fig. 12 shows a diagram of this useful type of loader.

A third type of modern loader may be referred to. This is the Eimco-Finlay machine ; it consists of a short truck carrying a bucket on a rotating arm. The truck, with the bucket lowered, is driven forward into the spoil heap and fills the bucket. A separate air motor then rotates the arm and causes the bucket to discharge into a wagon following behind the truck. This loader is shown diagrammatically in Fig. 13.

Several methods of haulage are adopted. The most common is by wagons drawn by a compressed air locomotive, by an electric locomotive taking power from an overhead trolley line, by an electric locomotive operating on storage batteries, or by a diesel locomotive. The wagons are sometimes hauled by an endless cable to which they are hitched ; the winding engine is usually placed outside the tunnel and may be driven by steam, oil or electricity.

The conveyor belt does not appear to have been applied except as a link between the loading machine and a chute tipping into the wagons.

A recent development is haulage by self-propelled petrol or diesel-engined lorries ; it has the advantage that no track is required, but it is suitable only in the case of large tunnels driven from an adit.

The petrol lorry can only be used where the ventilation is exceptionally good. In the case of the diesel-engined lorry, as carbon monoxide is not present in the exhaust, this limitation does not apply to the same extent, but good ventilation is necessary.

In tunnels being driven under compressed air some modification of the haulage system is necessary on account of the air lock. The wagons are pushed through the lock by hand, and separate haulage systems are required on the two sides of the lock.

At shafts the material is lifted to the

FIG. 15—*Forming Junction of Branch Line with Existing Tube Railway (London Passenger Transport Board)*

surface by crane, lift or elevator belt. When a crane is used the body of the wagon is lifted off the carriage, forming a skip. With a lift the wagon can be run direct on to the platform of the cage.

Some Special Problems in Tunnelling.—In the extension of the London tube system not only have new lines been built, but a considerable amount of reconstruction has been done. Some of the older tubes have been enlarged in diameter, stations have been remodelled and escalators added, and new lines have been connected up with existing ones.

All this has led to some very interesting engineering problems, especially when work has to be carried out without interference to traffic.

Fig. 14 shows a diagram of a new junction, and Fig. 15 the new tunnel constructed around the existing running tunnel. When the new tube has approached close to the old one, at point A (Fig. 14), its diameter is abruptly increased so as to embrace the existing tube. From here to the point B, where the two tubes merge into one, the diameter of the tunnel is gradually reduced in a series of steps. The length A B of the old tube is thus gradually exposed and encircled by the new tunnel, and as this occurs it is underpinned with a continuous concrete bolster resting on the new tube. For the last 25ft. or so, where the new tunnel has stepped down to a diameter only slightly greater than that of the old one, the work is carried out during the few hours at night when traffic is suspended. The point B having been reached, the old tube is dismantled ring by ring to rail bed level, the invert being left in. The new line is then connected up with the existing one in the usual manner.

CONCLUSION

In the brief space of a single lecture it has not been possible to do more than touch the fringe of so wide a subject. One hundred years ago tunnelling methods were much the same as they had been for many hundreds of years before, during which time the only important development had been the use of explosives. Hand work was used in drilling and clearing, haulage was by man or animal power, lighting by oil lamps, and ventilation fortuitous. Compare this with the conditions of modern tunnel construction, using the devices which the advance of mechanical science has rendered available. The tunnel is well lighted and ventilated during construction, whilst rapid drilling with pneumatic drills, clearing by mechanical diggers or scrapers, and mechanical haulage are all arranged in a co-ordinated effort which tends to rapid progress and economy. Or again, in a sub-aqueous tunnel, the water is kept back by compressed air, the excavation carried out and the lining erected under a self-propelled shield; and the whole work is adjusted to a smooth continuous process. The contrast between the two pictures illustrates the progress of a century of tunnelling, which I have endeavoured to trace in outline in this lecture.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PEACE AIMS

SIR,—May I thank Mr. I. V. Robinson for his long, careful and fair reply to my letter? I am tempted to pursue the discussion, but second thoughts—backed up by indolence—persuade me to leave the issue between us to your readers.

But as I was reading Mr. Robinson's arguments there kept running through my mind all the time that he and I and most of the rest of us are arguing about something none of us fully understand. That "something" is Money, and especially money administered by the State. And it occurred to me that possibly if we who are honestly looking for the light were to put our ideas on to paper we might between us strike out a spark, a gleam, even light a candle, to illuminate the feet of those who must be our guides in the near future.

Now, the most obvious fact about money is that it is not what it was. Solid money—except for the change of half a sovereign—has gone. Money is represented by scraps of paper which exhibit the credit of the owner but have no intrinsic value. Everyone knows that all business of any magnitude has been carried on for many a year by "credit," but it is only in the last quarter of a century or so that, in this country, credit has become the recognised method of financial dealings even in quite small transactions.

Money has become almost completely unreal. No one thinks nowadays of a war chest full of gold, as in Marlborough's days. The gold in the British Government's war chest is nothing like ample enough to pay out thirteen million pounds a day. Its gold reserves are little more than the oyster in the traditional steak, kidney and oyster pudding.

This little point, Sir, would not be worth making in your intelligent columns were it not that a great number of people speak and write as if the Government's financial resources were inexhaustible. You may hear people saying, "If the State can afford to spend £13 million a day on the war, they can afford to spend an equal amount on social developments after the war." Without examining that fallacy let us ask ourselves, "What is it, exactly, that the Government is doing?" The answer is manifestly that it is circulating the same "money" round and round. As fast as the money goes out—on home expenditure—it comes in again. Sooner or later it nearly all gets back into the hands of the Treasury, and as fast as it receives it the various Ministries spend it again.

Before the rotatory steam engine was perfected it was not uncommon practice to pump water up from a pond into a cistern, whence it fell upon an overshot wheel keyed to the shaft it was desired to rotate. The same water was used over and over again, whilst the product from the mill went on increasing. It is the same with war expenditure. The same "money" circulates round and round, turning the wheels that produce the munitions. The country is not spending (in the sense of forfeiting) £13 million a day. It is circulating money at that pace. It is pumped up, turns the industrial wheels, and falls back almost directly into the sump in the form of income tax, E.P.T., &c., or finds its way back by devious paths, just as the blood goes out from the heart by the arteries and returns by the veins and capillaries.

It need not be said that the efficiency of the machine is well below 100 per cent. Some of the money goes foreign, never to return, some gets dissipated; but sooner or later the bulk of it gets back to the Exchequer and is ready for recirculation. The wastage is made up by war loans.

I have fixed my mind on war expenditure in this little review, but I suggest that exactly the same thing takes place in normal times, only that instead of one pump, the Government pump, doing nearly all the work, a vast number of small pumps—factories, shops, ships, railways, &c. &c.—are keeping the money in circulation.

I must not take more of your space on the development of an idea which should be obvious, but does not appear to be. One thing, however, must be said in conclusion. The war mill, driven by the circulation of money at the rate of £13 million a day, is grinding the wind. It is turning out few, if any, assets that are themselves productive. The peace mill, on the other hand, produces a great number of productive assets, which will increase the amount of money in circulation, and in other ways augments the amount of money in the sump—that is to say, national wealth. One of the great Peace Aims should be to get the money quickly out of the Government "sump" and back into industrial and commercial "sumps."

Now, the bearing of all this on the policy of Mr. Robinson and his fellow-economists is that they think prosperity can be assured by the State adding untold millions of paper pounds to the sump. That is what we others call inflation. The specific gravity of the material in the sump would be reduced and more of it would have to be pumped to get the same useful effect from the wheel. ORTHODOCIAN.

December 8th.

SIR,—The opinion expressed by Mr. I. V. Robinson in your issue of November 28th, that a chronic deficiency of purchasing power is inherent in the present economic system, is not entirely supported by the facts. Such a deficiency occurs at one stage in the trade cycle, but it is balanced by a temporary surplus of purchasing power at a later stage. There is a phase difference between the rate of production and purchasing power, and if one is plotted against the other a closed diagram results like the hysteresis curve, with one side of the axis of the curve representing deficiency of purchasing power and the other side representing surplus. The explanation of the origin of the fluctuation between deficiency and surplus is set out below.

When trade is improving after a depression and production is gathering momentum, profits, keeping ahead of advances in wage and interest rates, at last begin to increase and are invested in new plant for increased output of goods to take advantage of the better times. Sooner or later, however, the construction of new plant will slacken and when that time comes saving will temporarily exceed investment. This is a critical point in the trade cycle. The excess of saving over investment is both a symptom of lack of confidence in a continued expansion of production and the cause of a temporary deficiency of purchasing power. There is plenty of money, a temporary excess of money, on the production side of the counter, but for the time being it is not being sent round fast enough to the consuming side, where there consequently arises a temporary deficiency of purchasing power.

This temporary deficiency of purchasing power is such a conspicuous phenomenon, occurring, as it does, just when there is a peak in production and when unemployment is beginning to increase, that it has been suggested that there is in fact a chronic deficiency in purchasing power and that this deficiency is due to a "flaw in industrial accountancy." The deficiency is, however, only a temporary one and will be made up at a later stage of the trade cycle when, with lower profits and a lag in wage and interest cuts, more money will be

distributed to consumers than will be at that time derived from production.

If the rate of production were stable it is quite certain that every penny received by producers for their goods would be distributed sooner or later to consumers; there is nowhere else for the money to go.

Although there is no chronic deficiency of purchasing power, the cyclical variation is a serious evil. It is suggested that a step towards its elimination might be made in the following manner.

At the stage when saving exceeds investment money begins to lie at deposit and loans are repaid. This is bad for the banking trade and the interest of bankers will be still to try to extend their loans and expand credit, whereas the interest of the rest of the community is to restrict credit. The real interest of the community is in fact that credit should have been restricted before the lack of balance began between the amounts of money on the production and consuming sides of industry. It is unreasonable to expect bankers to work against their own interest for the benefit of the rest of the community, and it is therefore suggested that some means of controlling credit, more effective and immediate than that at present exercised by the Bank of England, should be devised which would always operate in the interest of the country as a whole. The detailed form of this control is scarcely for engineers to determine, but one part of its work would be to restrict credit as soon as, or before, that point is reached where savings threaten to exceed investment. Similarly, in a depression, the credit control would be more ready to encourage constructional work than profit-making bankers can be expected to be. By these means the oscillations of the trade cycle could be damped down and with them would decline the fluctuations in purchasing power.

J. T. EVANS.

Nottingham, December 4th.

SIR,—Mr. I. V. Robinson's interesting letter, which appeared in your issue of November 28th, carries the discussion of peace aims a stage further.

In the first part of his letter he points out that, at the moment, there is no lack of purchasing power, but a surplus, and touches upon the measures which the Government has had to take to prevent this excess of purchasing power leading to inflation. In the second part of his letter he attempts to show how a scarcity of purchasing power arises in the periods between wars.

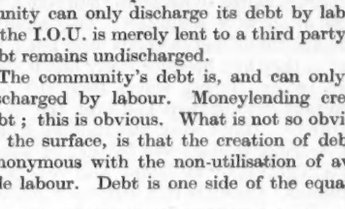
A little consideration of the problem will show, however, that there is no scarcity of purchasing power either in times of peace or war. The difference in the degree of employment during these periods arises, not from a difference in the amount of purchasing power available, but from the simple fact that in wartime the purchasing power is used, whereas in peacetime a large proportion of it remains unused. Why does it remain unused? The opinion is still held by many that money not spent on consumer goods must necessarily be spent on capital goods. If this were the case, the production of capital goods would be in inverse ratio to the production of consumption goods, but a glance at the accompanying diagram will show how wide of the mark is this popular belief.*

If, then, money is spent neither on capital equipment nor on consumer goods, how is it utilised? If it is doing nothing, how can it earn its owner a profit? Money spent provides employment; this statement will be generally accepted as being correct. But money need not be spent; there is no law which compels a man to spend his money. Money may be merely lent on security; such lending, instead of spending, results in unemployment.

The vital difference as regards the unemployment problem between spending and lending will be readily grasped if the problem is given some little thought.

Money is merely an I.O.U. of labour from the community; the community remains in debt until the owner spends his I.O.U. The community can only discharge its debt by labour. If the I.O.U. is merely lent to a third party the debt remains undischarged.

The community's debt is, and can only be, discharged by labour. Moneylending creates debt; this is obvious. What is not so obvious, on the surface, is that the creation of debt is synonymous with the non-utilisation of available labour. Debt is one side of the equation



PRODUCTION IN U.S.A.

"THE ENGINEER" SWAIN SC

and unemployment is the other, and so we have:

£100 spent = £100 worth of goods produced or labour employed.

£100 lent = £100 worth of debt created.

£100 worth of debt = £100 worth of goods owing.

£100 worth of goods owing = labour waiting for the opportunity to produce these goods.

The solution of the unemployment problem is dependent upon a method being found of ensuring a full week's income being spent each week. Must the Government issue credit to make up for that portion of the week's income which is saved?

Would it not be more sensible for the community to say to its individual members: You are entitled to a reward for your services, but we have no other way of rewarding you except by producing goods for you and rendering you service; this we are prepared to do, but we are not prepared to stand by in idleness because you, having secured a far larger share of the community's I.O.U.s (money) than you can utilise, will neither spend them yourself nor give them away for others to spend!

Sheffield, December 4th. N. H. BACON.

SIR,—Whenever the State needs great sums of money in a hurry, as in the case of war, inflation is resorted to. History tells us that King John, amongst others, "debased the currency." Modern Governments issue paper with only the State credit behind it, and raise loans which remain as permanent public debt. But at the end of a war the value of money is always down—the inflation is there. Prices in time adjust themselves, wealth is redistributed and individuals suffer. But then comes in the danger of political manipulation of the currency. During the short post-war boom of 1919–20–21 the wartime inflation had reduced the purchasing power of the 1914 sovereign to a little more than half, with a corresponding increase in the price of materials and in the wages paid to workpeople. A firm which had not built up and retained large cash reserves was therefore short of working capital, and the normal process was to borrow that capital in inflated money on debentures. Round about 1923 to 1926 the politicians and the financiers put their heads together and set to work to deflate the currency and get back to the gold standard. The firm which had borrowed inflated money at 5 per cent. and 6 per cent. on debentures now found itself under the obligation of paying the interest and continuing to owe the principal in deflated money, and the result, to put it shortly, was that in scores and hundreds of cases the ordinary shareholder walked out with nothing and the debenture holder walked in and smashed up the business or carried out some kind of reconstruction. At the same time, the effect of deflation on the export trade was disastrous. Whilst a stable currency is essential to industrial prosperity, inflation and deflation offer great opportunities to speculative finance, and deflation is the worst of the two in its results. It is a question for consideration whether the system of usury (*i.e.*, interest on loans) should be strictly and permanently controlled. If this were done it might be possible to maintain the personal ownership of share capital and protect it against the issue of prior liens. However, a system under which three parties—the industrialist, the financier and the politician—struggle for the control of industry is obviously wasteful and may cause a swing over to public ownership as being the lesser evil of the two.

The foregoing suggestions do not cover the future of agriculture. Is that great national interest to be again sacrificed to party malice and greed when the present crisis is past? It should be clear to everyone that the extraction of capital from the land by taxation, and the favour so long shown to imported as against home-grown food, are the real reasons why we are now allowed two eggs per month and very little butter and cheese, and also why some of the best land in the world is now, in a violent hurry, being drained and ploughed regardless of expense and brought back into cultivation. The politicians, having destroyed the ancient land system and made the peasant a slave to the town dweller (because the latter had the most votes), must find something to put in place of the old rural organisation.

Unless and until such fundamental problems are dealt with, proposals such as "consumer credit" or living allowances seem like distribution of unrealised profits, and neither peace nor peace aims will last long if we are again misled into the lunacy of disarmament.

FRANK L. WATSON,
M. Inst. C.E., M.I. Mech. E.

Leeds, December 8th.

TANDEM RODS ON LOCOMOTIVES

SIR,—With regard to the tandem rods fitted to the C.P.R. "3000" class 4–4–4 engines, mentioned in my article [in our issue of November 21st], Mr. Bowen, the C.M.E. of the C.P.R., writes: "Tandem rods on our '3000' class locomotives are not giving any trouble, and while we did not like to apply them to these engines, due to trouble experienced on our heavy '3100' class locomotives, it was thought that, on account of their light weight, we would be justified in using the tandem rod drive in order to keep the distance between cylinder centres to a minimum. We do not, however, look with favour on the tandem rod drive for heavy classes of locomotives, due to trouble in replacing bushings on the back rod, and from overheating of bushings, due to their moving sideways and taking up the lateral clearance, to say nothing of the increased counterbalance required and the higher stresses thrown on the pins, due to the heavy revolving parts at a greater distance from the hub face of the wheel than is necessary with the ordinary side rod arrangement." EDWARD H. LIVESAY.

Victoria, B.C., October 28th.

* O'Rahilly—"Money," 1941, p. 319.

American Engineering News

Large Ground-Water Water Supply

For a large smokeless powder works of the United States Government, built recently in Indiana, the water supply system will be the largest ground-water plant ever built, having a capacity of 50,000 gallons per minute. To produce this supply there are seven concrete-lined wells or shafts, 13ft. in inside diameter and 85ft. to 110ft. deep, closed at the bottom with a concrete plug 7ft. thick. Near the bottom and 3ft. apart vertically are three rows of 8in. pipe, driven horizontally and radially into the water bearing formation, into which they extend for about 250ft. from the shaft. These pipes are copper-bearing steel, ¼in. thick, the flat plates being punched with slots 2in. long and ⅜in. wide, and then bent to circular form and welded at the seam or joint. The pipes, in 8ft. lengths, are forced out from the shaft by means of two 100-ton hydraulic jacks, which are backed against the 18in. wall of the shaft opposite a porthole through which the pipe is driven. As each new 8ft. length is placed it is welded to the previous length. From four to eight lengths were driven in an eight-hour working day. At the top of each shaft is a pump-house of concrete, 20ft. by 30ft. in plan, containing two 20in. deep-well five-stage centrifugal pumps of 450 H.P., having a capacity of 3600 gallons per minute. The pumps discharge into two mains of 36in. cast iron pipe, leading to the storage tanks at the powder works. At each well is a transformer taking 11,500-volt, three-phase, 60-cycle current from a transmission line and delivering it to the pump motors at 2300 volts. With a low infiltration velocity there will be little or no clogging of the inlet slots. The water is clear and requires no treatment for industrial purposes, while that for domestic use is chlorinated as a safety measure. It has a uniform temperature of approximately 60 deg. Fah. throughout the year, and its iron content is less than 0·01 part per million.

American Bessemer Steel Developments

Within the past few years there has been a marked increase of interest in Bessemer steel in the United States, and particularly as to a higher degree of study and practice concerning details of the process which affect materially the character and cost of the product. Tests have indicated that for equivalent carbon content, Bessemer steels averaged 15,000 lb. higher tensile strength than open-hearth steel, while for the same tensile strength the former required 0·14 per cent. less carbon. The higher strength is attributed to higher phosphorus (0·090 per cent. as against 0·013 per cent.) and higher nitrogen. Both elongation and the ratio of yield point to ultimate strength were higher in the Bessemer steel. It was considered evident that control of temperature, degree of oxidation, and nitrogen content are basic problems. Greater attention to technical features of the process has been amply repaid in better quality. An important feature that has been largely neglected is that of the quality and quantity of the air blown into the converter. For instance, of 170 technical reports on the Bessemer process, less than 10 per cent. dealt with the pneumatic phase of the process, all the others dealing with metallurgical aspects. It is suggested that the humidity of the blast be maintained uniform, either by refrigeration or—preferably—by injection of moisture, the blast operator to have control in either case. Incidentally, it is suggested that the operator be provided with instruments that can aid in improving the product, and that he be provided with a decent place in which to work in comfort. From a study of actual operations at different mills, the conclusion was drawn that the blowing process is handled inconsistently and sometimes with rule-of-thumb methods. One writer has pointed out that in spite of the obvious advantages in using the spectroscope to analyse the flame, this instrument is now seldom used, since it gives qualitative information when quantitive information is desired. But with control by photo-cells, there is rapid and quantitative indication of changes in the flame, and these are recorded graphically for each blow.

Flow and Rupture of Metals

The difference in the meaning of "flow" and "rupture" of metals was the subject of a lecture before the American Institute of Metals, in which it was stated that until recent years these two fundamental phenomena were treated simultaneously in relation to the failure of solid metal. The plastic behaviour of a metal follows the rule that large and small articles of the same shape deform alike under the same stress values. Thus, large and small test bars for tension and compression show identical properties, the general trend of the stress-strain diagram of a metal being independent of the section size. It appears that there are no known exceptions to this rule. But if deformation is continued until rupture occurs, a test bar of large cross section appears to fail before, or at lower stresses than a bar of smaller section. This is particularly the case with metals of limited ductility. In the same way, fatigue-strength values usually decrease with increasing sectional size. The calculation is that the ductility of a homogeneous metal decreases with increasing sectional size. This branch of metallurgy is most nearly akin to the theory of elasticity, the plasticity and rupture of metals depending upon numerous fundamental factors and specific metal properties. In mechanical work upon metals, both cold working and hot working are converted into heat, partly resulting from strain within the metal and partly from friction at the tool. But as yet little has been done to apply the laws of heat transfer to metal-working problems. Extensive theoretical and experimental work is necessary for further development in this particular field of metallurgy. However, progress must necessarily be slow, since the work requires the use of sensitive, complicated, and expensive apparatus. Application of the fundamental conceptions to plastic flow of metals encounters as a principal difficulty the fact that flow is not uniform in a commercial working process.

Sixty Years Ago

THE CANONBURY ACCIDENT

ON the morning of December 10th, 1881, a Great Northern train was held up by signal on the branch line connecting the Great Northern Railway at Finsbury Park with the North London Railway at Canonbury. It was stopped with the engine just clear of the 750-yard-long tunnel through which the line passed, the rest of the train being still within the tunnel. While stationary it was run into behind by a second train from Finsbury Park, which had left that station four minutes after the first. The impact was very slight and almost as soon as it occurred the signal was lowered and the first train proceeded uninjured towards Canonbury. The second train was now occupying the position of the first and while so standing was run into from behind by a third train from Finsbury Park. The impact this time was very severe. Both lines in the tunnel were blocked and great confusion prevailed. Then a fourth train from Finsbury Park approached and ran into the wreckage with disastrous results, five people at least being killed and forty injured. In this way between 8.50 a.m. and 9.12 a.m. three trains were smashed up in two heavy collisions. The explanation of the accident, as set forth in a leading article in our issue of December 16th, 1881, illustrated the fact that the block system as then practised was far less perfect than some railway managers appeared to believe. There was a block signal box staffed by the Great Northern near the Finsbury Park end of the tunnel and another box staffed by the North London Railway outside the Canonbury end. At 8.55 a.m. signalman Hills, the North London man at the Canonbury end, sent six beats on the telegraph instrument to signalman Hovey, the Great Northern man at the Finsbury Park end, to indicate that the section was blocked by the first train. Nevertheless, Hovey sent on the second train, which collided lightly with the first. Then Hovey sent Hills word that he was sending on a third train. Hills apparently in desperation signalled seven bells to Hovey, the seventh bell being intended, in accordance with the North London code, to emphasise the warning not to send on any more trains. Hovey did not understand the meaning of the seven-bell warning. He consulted his code card and found that it meant "obstruction of line and permissive block." He took the rule to mean that he could send on a train with great caution. Almost at the instant of the collision between the second and third trains Hills received a further message from Hovey that he was sending on yet a fourth train. Hills again replied with seven bells and again Hovey misread the message. It is possible that yet other trains would have been involved in the disaster had not someone apparently gone to Hovey's box and told him verbally that he was wrecking trains as fast as he could. It seems quite certain that each signalman acted correctly in accordance with his company's code and that seven bells on the North London meant something quite different from what they did on the Great Northern. In our leading article we emphasised the necessity of a uniform code of telegraph signals on all British railways and urged that as an additional precaution adjacent signal boxes should be connected by telephone.

PAPER SALVAGE

SEVERAL weeks ago Lord Beaverbrook called for an armaments production in this country increased by 30 to 40 per cent., in order that our promises to Russia should be redeemed without effectively reducing the supplies for our own Forces. In his speech before Parliament last Monday, following upon the treacherous attack by Japan upon American possessions in the Pacific, upon Hong Kong and upon Malaya, Mr. Churchill emphasised that armaments production in this country must be still further increased. One of the effects of any increased production will be a greater demand for paper. For paper is required, indirectly and directly, for the packing and in the manufacture of munitions of war.

A paper salvage campaign is already in full swing and every person in the land is being encouraged to take part in it. One of the consequences of the entry of Japan into the war is likely to be an intensification of that drive. Engineering firms have already for the most part, it is to be hoped, turned out to waste paper merchants those old ledgers and account books, old drawings, old blue prints, books and catalogues and various other stored material of little value. Such things have helped to raise that 100,000 tons of paper that Lord Beaverbrook recently demanded as an immediate contribution. Now they are making arrangements to collect, as week follows week, what may be termed the "current" wastage, so that every scrap of otherwise useless paper is made available for the war effort. Such paper, if in sufficient bulk, can be offered to waste paper merchants, who pay standard prices per hundredweight according to the particular quality of the material, as follows:—

	Per cwt. s.	d.
Old ledgers, account books, &c.	6	0
Office letters, records, invoices, &c. ...	5	0
Magazines and books	5	0
Newspapers	6	6
Mixed office waste	2	0

RUBBER FOR ALUMINIUM.—The United States Rubber Company has developed a material, known as yet only by a formula, with which it is hoped to provide a non-metallic substitute for sheet aluminium in several important uses. The new material is made from fibrous and rubber-like ingredients and except for small amounts of rubber the formula uses non-strategic materials. The new material is expected to find many applications in normal industry.

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Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

AMERICAN SHIPBUILDING

WE have been told to some extent by Mr. Winston Churchill what the people of the United States are doing to assist us to win the war. Not least amongst these efforts is the shipbuilding programme of the United States. Quite apart from the naval shipbuilding, the Americans have embarked upon a programme of mercantile shipbuilding which, the Premier has said, should in 1942, in addition to maintaining our supplies of commodities, enable us to move large bodies of troops to our battle fronts. To the October issue of the *Foreign Commerce Weekly*, the journal of the United States Department of Commerce, the Chairman of the United States Maritime Commission (Rear-Admiral Emory S. Land, U.S.N., Retired) has contributed an article which illustrates the magnitude of the programme which the United States has put in hand. After the last war the American Mercantile marine was of considerable importance, but it was allowed to decline. The United States Maritime Commission is now building a huge fleet of merchant ships. The whole of the country's shipbuilding industry has been brought into the effort and a number of new yards have been constructed. At present there are thirty-two United States shipyards with 234 slipways devoted to building merchant ships. Between 1922 and 1937 only two ocean-going cargo ships were produced in the United States shipyards, and during these fifteen years the United States marine, writes Admiral Land, only acquired such worn-out tramp steamers as other nations discarded. The Maritime Commission undertook a survey in 1937, which showed that the country would need to construct 500 ships in ten years to make itself independent and secure maritime influence. That meant a ship every week.

When the war produced an urgent need for ships a total of 398 vessels was ordered by the Commission and 200 specially designed cargo vessels of a type known as the "liberty ship" were added to the construction programme. At the same time, seven new shipyards were constructed. The requirements of the American lend-lease law resulted in the programme being extended by 222 ships. This was further added to in July, 1941, as a result of the Supplementary Appropriations Bill, so that the shipbuilding programme which started in 1937 to produce 500 ships in ten years developed into an enormous emergency project of approximately 1400 ships, of which the majority must be produced by 1944; that is, from one ship a week in the original programme the United States Maritime Commission is now planning to deliver into service an average of approximately two ships per day throughout 1942 and 1943. American shipbuilding tends to develop on standardised lines and, in addition to vessels of 28,482 tons, like the passenger liner "America"—the largest ever to be constructed in the United States shipyards—it includes twin-screw tankers capable of carrying more than six million gallons of oil and "C" type and "Liberty" cargo vessels. These vessels will be built to a standard suitable for United States export and import trade. The foreign commerce of the country is mainly confined to twenty international trading areas, for which it is the policy of the Maritime Commission to provide ships to maintain the predominance of American trade in those areas. This shipbuilding programme involves, with the approval of Congress, a total investment by the United States Government of about 1715 million dollars, whilst the combined construction programmes for which funds have been appropriated or authorised contemplate an investment of more than 3000 million dollars. Admiral Land points out that the Commission has three major jobs. First, it is building merchant ships; second, it is allocating available vessels so as to meet efficiently and adequately the defence needs, not only of the United States, but of the British Empire and such other allies as democracy may obtain; and third, it is maintaining, and even increasing, inter-American commercial trade. He claims, in addition, that the Commission is making it possible for private enterprise to survive a period of tremendous international disturbance and competition by subsidies and will continue to do everything in its power to make it possible for private shipyards as well as private transportation organisations to participate in the post-war opportunities of the future. The Commission has granted emergency subsidies to many experienced managements so that in the face of increasing private liabilities they could sustain their organisations. At the end of June, 1941, after four years' activity, the position was that the total American-flag fleet comprised 1168 vessels, totalling 6,841,561 tons. Of this total American mercantile fleet, 1092 vessels were privately owned and only 76 were owned by the Government; 6,335,098 gross tons were privately owned and 506,463 were owned by the Government. Admiral Land estimates that the American shipyards' programme covers 6,500,000 tons in both 1942 and 1943, which should be a total sufficient to replace the sinkings of British and neutral ships at the peak rate of 1941 and more than ample to make good those replacements if future losses do not exceed the present reduced level.

In a world in which bureaucracy seems to be endeavouring to dig itself into positions won during the war, it is refreshing to find that the United States Maritime Commission is working, and will continue to work, in so far as is practicable, to preserve private managements. Admiral Land points out that the American people have been traditionally opposed to the entry of the Government into business, and although he gives a long list of private enterprises which the Commission has sustained during these complicated months, he states that it is impossible to list all the private enterprises which it has assisted. Every reliable shipbuilding or ship operating company in the United States has participated in the Commission's programme. The post-war problems which the shipping industries of all countries will have to face cannot yet be predicted, but he claims that his country must be in a position to meet every economic competitive condition which confronts it. "American ships," he says, "must be available and ready to carry a greater proportion than ever before of the post-war world commerce." What the post-war problems will be can only be guessed at and much will depend upon the policies which individual nations will adopt towards export and import trade. It is generally accepted that these must be based and will be based so far as the United States and Great Britain are concerned upon the principles of the Atlantic Charter. Present indications are that very large merchant fleets will survive the war in the hands of the United States and the British Empire, the parties to the Charter. No doubt the principles of that instrument were drawn with a view to assisting post-war international trade rather than limiting it, and the interests of neutral nations will not be lost sight of, but the position can be envisaged of a world in which

the available merchant navies will exceed the work they will normally be called upon to do.

The Wartime Foreman

A YEAR or two ago an article appeared in these columns on the new type of foreman that was finding his way into industry, a man of broader general education and higher technical attainments. The foreman's position is so important and the man himself can have so far-reaching an influence on production, that we feel fully justified in examining the situation once again. Without in any way departing from our contention that it is desirable to obtain the best possible type of man, it is suggested that the requirements for wartime production differ materially from those of peacetime. The average engineering works normally has to be prepared to undertake the manufacture of a variety of articles, often demanding considerable ingenuity on the part of the foreman to work them all efficiently into the programme. Admittedly, this work may be planned for him, but it is often necessary for him to depart from the prescribed course, to improvise, and always to ensure keeping his men fully occupied. He may also on occasion have to be ready to answer the criticism of the customer who comes into the workshop to see the progress of the article in which he is personally interested. In other words, the peacetime foreman must be a man of parts. But under war conditions there is often but one customer, and that the Government, and there may be one commodity only being produced, but that is required in the greatest possible numbers, and in the least possible time. No longer is it a feasible proposition to prevail on young university graduates to accept appointments as foremen—there are too many other tempting opportunities presented to them—but it might come as rather a shock to them if they were told that they were not likely to prove to be the best type of wartime foreman.

The foreman in wartime must be a man who, above all, can control his men, who can, by his own example, rather than by precept, inspire them to further effort, however great their former exertion may have been, and he must himself be able to set a good example in time-keeping, economy in material and stores, and set a high standard for general conduct. Who better can be selected for this arduous post than the man who has been brought up with his fellows, and has already earned their respect? The fitter who has merited the notice of the manager for his zeal and ability may prove to be an excellent foreman for the fitting shop, and the turner who has maintained an unblemished record and obtained a high output from his own machine may reasonably be expected to be suitable for a wartime machine shop foreman. It may, however, be argued that such men have not reached a high enough standard of technical attainment, and that they are not likely to be able to take a broad view of the problems with which they find themselves confronted; while, on the other hand, the man who has been trained in the drawing-office is more likely to be a success. Has he not had a hand in the design of the very product which has to be passed through the shops? Will he not better work to the drawings for which he himself may have been responsible? To such criticism we should reply that there is no call for much technical achievement to enable a man to obtain the best results under mass production methods, and that the man we have in mind is far more likely to understand the idiosyncracies of the working man than is his colleague who has spent his days amid the more sheltered surroundings of the drawing-office. There is no cogent reason why a foreman should be a designer; indeed, it is doubtful whether the analytical mind that is useful in the drawing-office is really an unmixed blessing in the workshop. Provided a foreman can read a drawing intelligently and quickly, and that it conjures up in his mind a correct impression of the article it depicts, there is no need for him to be handicapped by lack of draughtsmanship, although admittedly the ability to make a good freehand sketch is an indisputable asset. When every moment is of value, there is the added advantage that, whereas when a designer or draughtsman is promoted to the post of foreman, it takes him a very appreciable time to absorb the atmosphere of the particular shop he is destined to direct, the promoted mechanic already knows his men, he has sojourned among them, and the manager himself is well aware of the strong points of his new foreman, as well as of his limitations, so that the new order of things soon settles down on a working basis.

The commonly accepted dictum that "once a foreman, always a foreman," is not easy to eradicate, and it is often found that management is prone mentally to resolve foremen into two categories—those who are not a real success, and accordingly do not merit promotion, and those who are so useful in their particular sphere that it would be unwise to shift them, suggesting as a salve to the conscience that an excellent foreman does not necessarily make even a passable assistant manager! An outlook easy to acquire! Cases come to mind, however, where a foreman by sheer ability and forcefulness of character has made his way through the various stages of management until eventually he has become one of the directors of the company. We are convinced that this is not "the exception that proves the rule," but we rather suggest that the management might with advantage seriously consider the best avenue of promotion for intelligent foremen, endeavour by every possible means to broaden their outlook, and finally to encourage them on their own account to do all in their power to fit themselves for assuming an increased measure of responsibility. Under war conditions a good mechanic is not likely to gain much financially by accepting a foreman's post—he may even lose thereby—but if he has a reasonable prospect of future advancement, the better type of man would be far more ready to forego big piecework earnings, and to accept a position that placed him on the first rung of the ladder of management. Now is the opportunity for those in authority to give their own employees well-deserved recognition; now is the opportunity for the British workman to show that he can take a post of supervision and hold it with distinction.

Literature

Economic Peace Aims. By OSWALD DUTCH. London: Edward Arnold and Co. Price 12s. 6d.

BEFORE this war began, even perhaps only a year ago, we should have regarded a book such as this as outside our field. Now, however, with the growing realisation in this country, as elsewhere, that the business of reorganising the shattered economic organisation of the world after the war is something so important in its effects upon them, that engineers cannot afford to neglect the subject, we feel at liberty to express an opinion about it.

Many minds have been busy for long years past considering and pointing out what were those mistakes that made the period "between the wars" so unsatisfactory and so miserably doomed to failure. New ideas are in evolution regarding the theories of economics. It is becoming more and more realised on a world-wide scale, even in the Middle West of America, the home of Isolation, even perhaps in the U.S.S.R., a country more or less cut off since 1918 from the rest of the world, that prosperity is indivisible and that the prosperity of one country at the expense of others, if it can be experienced at all, cannot possibly be more than transitory. It is upon that background that Mr. Dutch has written his book. He has drawn a picture of Europe as it might be after the war were the separate nations that compose it to settle their differences and consent to be welded into a Commonwealth with a single currency and no customs barriers to which the British Empire and the United States of America would be more loosely linked. Mr. Dutch appears to think that by a not impossibly great effort on the part of Britain and America this idealistic union could be brought about. To practical people like engineers, who would be among the very first to see the advantages of some such system, Mr. Dutch's book will seem compounded principally of wishful thinking. But however unlikely it may seem that in a post-war welter of struggling nationalities, each with its own wrongs to be avenged, any immediate co-operation is likely to emerge and blossom into a Commonwealth or a Federation, the working out in the latter half of the book of the economic organisation of the Commonwealth and of the world in general is of interest. Though it lacks detail, though it is perhaps tinged with political bias, it is provocative of thought and of criticism and whatever the post-war state of Europe it has some practical bearing on the economic measures and the attitude towards them that Britain and America will have to take if there is to be any hope of a better and more peaceful world in the future.

BOOKS RECEIVED

Transients in Electric Circuits. By W. B. Coulthard. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 25s.

A Dictionary of Electrical Terms. Fourth edition. By S. R. Roget. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 12s. 6d.

Metal Aircraft for the Mechanic. Third edition. By J. Healey. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 5s.

Teach Yourself Mechanics. By P. Abbott, B.A. London: The English Universities Press, Ltd., Little Paul's House, Warwick Square, E.C.4. Price 2s. 6d.

Understanding Aero-engines. By W. Hazel. London: The English Universities Press, Ltd., Little Paul's House, Warwick Square, E.C.4. Price 2s. 6d.

Air Force Targets in Germany

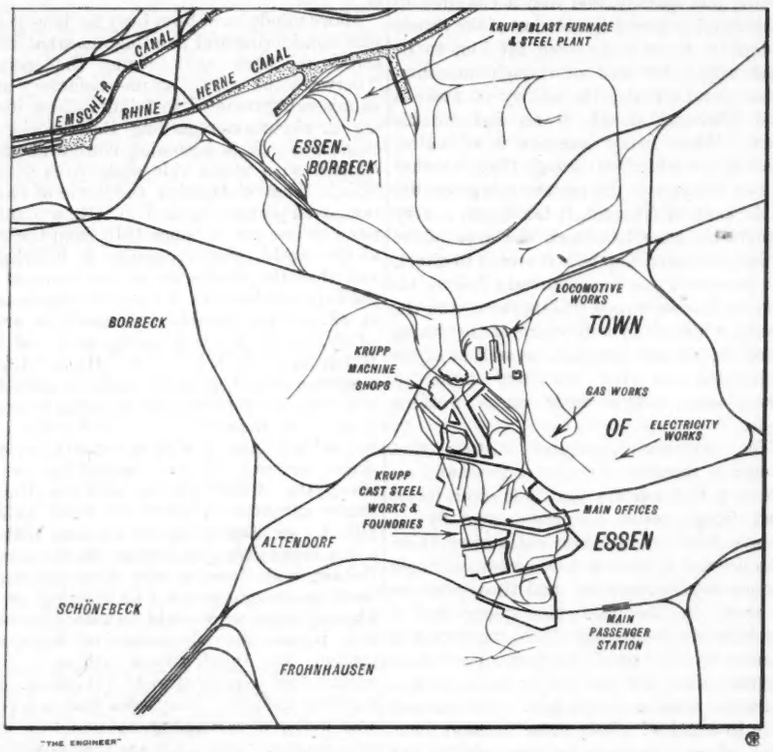
No. XXV

(Continued from page 327, November 14th)

ESSEN

THE Rhineland town of Essen, with its extensive railway connections, marshalling yards, collieries, steel works and engineering works, has been prominent among the targets attacked by the Bomber Command in North-Western Germany. Up to July, 1941, the town and district of Essen had been visited by bomber aircraft no less than thirty-eight times, to which must be added the raids which have been made in the last four months.

A typical raid was the sharp attack made by aircraft of the Bomber Command on Saturday, November 8th, on the iron, steel and armament industries of Essen, when the weather was favourable and there were only patches of low cumulus cloud, giving good visibility in the frequent cloud gaps. As on previous occasions, a feature of the ground defence was the crowded number of searchlights and the large number of anti-aircraft guns, giving clear evidence of the importance of the target to be attacked. In and around Essen itself were large groups of searchlights, as many as eighty to a single cone forming a blaze of light to protect the indispensable war industries of the town. Although our bombers were caught again and again in lights and then subjected to an intense barrage, the attack was pressed home. The Air Ministry *communiqué* says that in a short while many of our bomber crews saw violent explosions and watched large fires spring up, which lit the sky for many miles on the return journey.



MAP OF ESSEN

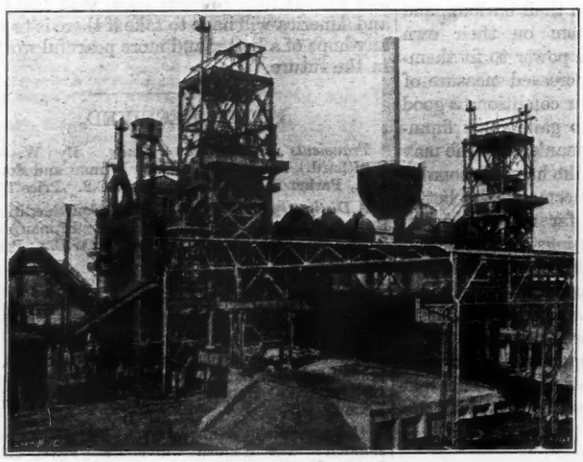
THE TOWN OF ESSEN

The town of Essen is a centre for railway administration and it is situated in the heart of the Ruhr industrial district, a little north of the River Ruhr, which flows into the River Rhine just above Duisberg. Although Essen is the home of various industrial activities, the principal interest is attached to the world-famous armament works of the Fried. Krupp Aktiengesellschaft. The company is one of the most important industrial concerns in Germany, and it owns and operates, besides the large Essen works, iron ore mines, collieries, blast-furnaces, steel works, forges and foundries, and rolling mills and engineering works. The branches we refer to include the Friedrich-Alfred Hütte iron and steel works at Rheinhausen on the Lower Rhine, coal mines at Hordel, near Bochum, Constantin der Grosse, near Bochum, Emscher-Lippe at Datteln, in Westphalia, and iron ore mines at Giessen. At Magdeberg-Buckau are the famous works of the Fried. Krupp Grusonwerk A.G., while at Kiel-Gaarden is the shipyard and marine engine works of the Fried. Krupp Germania Werft A.G.

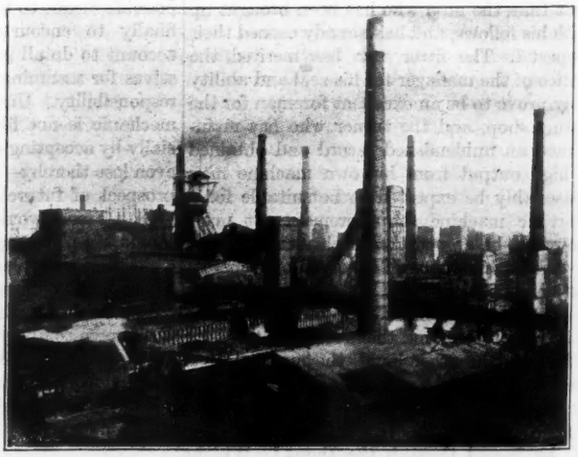
THE ESSEN WORKS

As the accompanying plan shows, the works at Essen are situated to the west of the town and are ringed round by railway connections. The two main branches of Krupps are the cast steel works and the engineering works, which are built on a site of more than 2150 acres, close upon 300 acres being covered by factories and workshops. Just before the war some 180,000 persons were being employed at the Essen works, and it can be safely assumed that the number employed under war conditions has now exceeded 200,000 persons.

Before dealing with the different sections of the works some milestones in their history may be briefly referred to, especially as the firm was started at a period in history when Britain was blockading the Continent of Europe in the Napoleonic wars. In 1811–12 Friedrich Krupp, a merchant of Essen, founded the works to produce crucible steel, which it was then impossible to import from Sheffield. The first few years were marked by constant failures and costly research, but success finally came, and in 1822 the first crucible steel foundry was built. There is in the centre of the modern works the so-



BLAST FURNACE PLANT

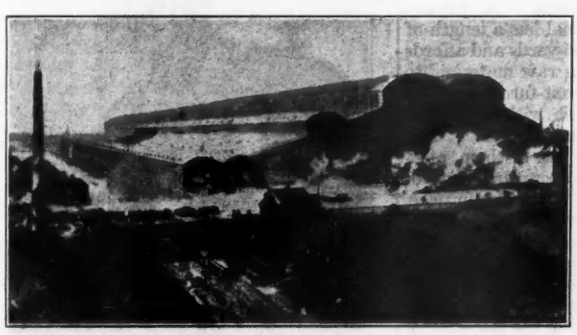


SALZER-NEUACK COLLIERY

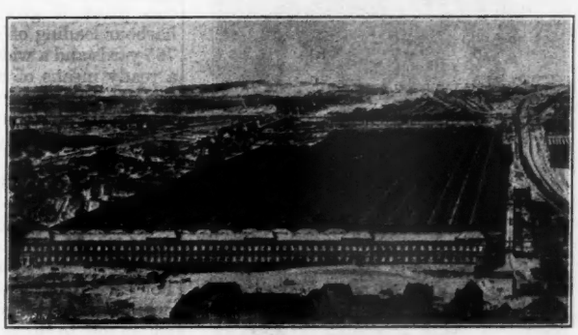
called "Stammhaus," in which the founder of the company, Alfred Krupp, along with his mother, brother and sisters, lived until the beginning of the 'forties, when that small foreman's dwelling was exchanged for a two-storied house which was built alongside it and has since been demolished. In the early years of the undertaking the products produced included cutlery, dies for stampings, and hardened polished steel rolls, such as are employed for the finishing of gold, silver and brass, but the works did not prosper owing to the unfavourable economic conditions which then existed. Friedrich Krupp died at the early age of thirty-nine, leaving his family almost in a needy condition and his business virtually bankrupt. Krupp's eldest son, Alfred, although only 14½ years of age, undertook to carry on the then small and practically dormant factory. Under his vigorous and penetrating foresight the business recovered and was soon put on a sound basis. By extending the melting shops and the forging plant so that increasing sizes of steel ingots could be cast and forged the output of steel was steadily increased. With the development of railways in Germany came the need for springs for locomotives and rolling stock, axles and wheel centres, while at a later date weldless types of steel tyres were invented. A large trade was also done in marine forgings and crankshafts for locomotives and marine engines. Following the production of crucible steel the manufacture of Bessemer and Siemens-Martin steels was introduced on a large scale, and alongside the foundries and forges general machine shops were built, and with the rise of the German army special shops for the manufacture of guns and gun carriages were built and equipped. Alfred Krupp directed his attention towards securing independence for his firm as regards the supply of raw materials by acquiring his own coal mines, iron ore mines and blast-furnaces, and at the time of his death in 1887 the number of employees had risen to 21,000 and the name of Krupp was well established.

The direction of the company was continued after his father's death by Friedrich Alfred Krupp, who was destined to lead the business for fifteen years. During that period his guidance was primarily concentrated on the general and more important questions of policy which affected the development of the undertaking. He devoted himself with special zeal to the pursuit of welfare schemes, some of which had been initiated by his father at a time when little attention was generally given to such matters. It was about that time that the colonies of houses for the workmen and staff were built at Essen and household supply stores were established, while facilities for recreation were provided and hospitals and convalescent homes laid out and built. The position of some of these housing colonies at Altenhof, Krönenberg, Alfredshof and Margaretehöhe are indicated in the map

AERIAL VIEW OF CAST STEEL WORKS

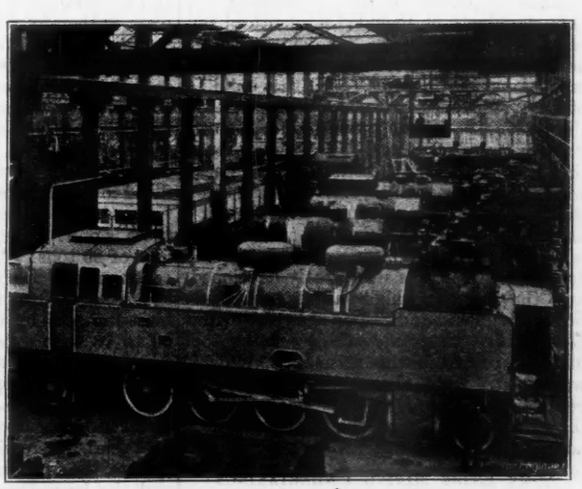


MACHINE SHOP NO. 9



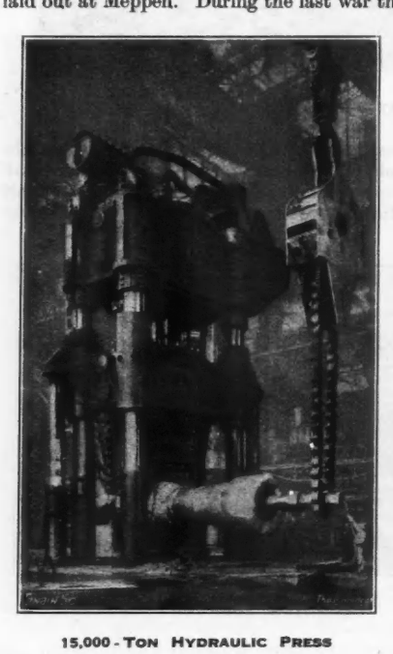
LOCOMOTIVE SHOP

MACHINING WELDLESS HIGH-PRESSURE BOILERS



INTERIOR OF LOCOMOTIVE SHOP

herewith. The late Friedrich Alfred Krupp was also greatly interested in scientific research, and under his guidance the large chemical and physical department was started with its well-equipped laboratories. A direct result of the research work carried out was the manufacture of the firm's own tool steel and the increased defensive power of Krupp armour plate by alloying the steel then employed in its manufacture with nickel and chromium. In 1902 Krupp died and left the works to his daughter Bertha, who four years later married Dr. Gustav von Bohlen und Halbach. He was elected to the governing committee of the Fried. Krupp A.G., which was then made into a joint stock company, and in 1909 he became the head of the concern. About 1910 the sphere of activity of the Essen works embraced the manufacture of high-grade steels and their manifold applications to railway and general engineering work, tools, marine and naval work, automobile construction and the manufacture of guns for the German Army and Navy, for which a special proving ground was laid out at Meppen. During the last war the



15,000-TON HYDRAULIC PRESS

production of the works was tremendous and under the peace terms much of the wartime plant was confiscated and delivered to the Allies. In the years following 1918 changes in production were introduced and new manufactures included agricultural implements, fine steels for surgical and dental purposes, including instruments and stainless steel dentures, and the building of cash registers and locomotives. Among the new steels which were produced in the years between 1918 and 1939 we may recall the non-rusting and acid-resisting steels, which date back to 1912, heat-resisting steel, such as "Ferrotherm" and "Nierotherm" and the non-ageing "Izett" steels. The treatment of steel surfaces by the aluminising and nitriding process was greatly developed, and the range of high-output tool steels further increased and extended by the manufacture of a tungsten carbide cutting tool material to which the name of "Widia" was given. With the development of the aeroplane and the motor-car special steels for the aircraft and automobile industries were added to the firm's range.

SOME ESSEN MINING UNDERTAKINGS

The Fried. Krupp A.G. owns near Essen some 450 acres of coal-bearing land and possesses mining rights over 1900 acres. There are seven shafts, coal being drawn from three of them. Over 5000 miners are employed in the pits, which are of modern design. We show in one of our engravings a view of the Sälzer-Neuack collieries, and there are other collieries on the eastern side of the town. Ten years ago there were 320 coke ovens with a combined capacity of 740,000 tons of coke per annum. Other associated collieries are the Hannover-Hannibal pits at Hordel, near Bochum, the Emscher-Lippe collieries at Datteln, in Westphalia, and the Constantin der Grosse Mining Company at Bochum. These collieries have a total output of close upon 11½ million tons of coal per annum, about one-quarter of which is used for the firm's own works. The iron ore properties of the Krupp concern are worked by the Sieg-Lahn Bergbau Company, of Giessen, which operates the ore deposits in the Siegerland, the Westerwald on the River Lahn, and those in the Spessart mountains. The Fried. Krupp A.G. is also interested in other ore mines both in Germany and abroad.

THE BORBECK BLAST-FURNACE AND STEEL PLANT

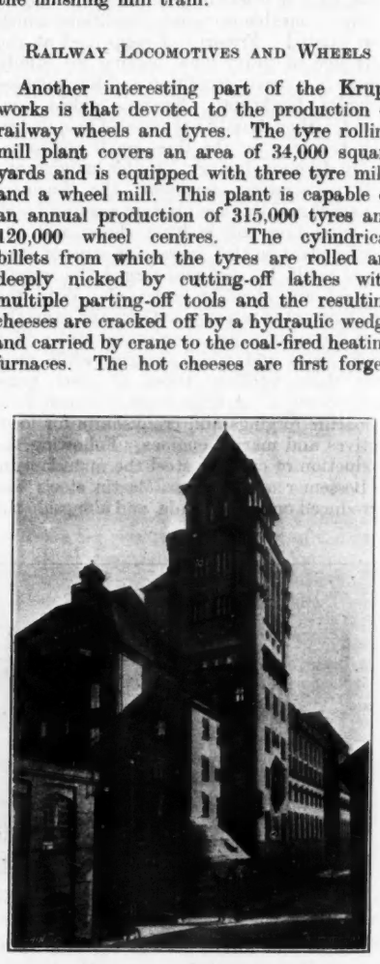
The production of steel at the Essen works has been placed on a broader basis by the erection of a further modern blast-furnace and steel plant at Essen-Borbeck, at the extreme north of the Essen factory site, up against the Rhine Herne Canal. A view of this plant is given herewith. A private harbour leading off the canal has a length of 765 yards and a width of 65 yards and affords a ready means of bringing raw materials to the site. There are two blast-furnaces of the latest suspended type, each with an output of 500 tons a day. These furnaces were blown in during 1929 and one of them, after being engaged on high temperature duty for seven years, was re-lined. The other furnace, which is working at a lower temperature, is capable of longer continuous service. Each furnace is served by three Cowper stoves. For each furnace the whole of the charging operations is controlled by two men, one of whom sees to the assembly of the material for the charging skip, while the other operates the hoist, the bells, and the charge indicators. Close by the furnaces there is a new plant for the improvement of German ores. Before the war a large proportion of Swedish ore was also used.

At this Krupp plant the gas is burnt under boilers which supply steam to turbo-blowers, and the amount of space devoted to blowing plant is thereby very much reduced. There are two Brown-Boveri blowers, each capable of delivering 120,000 cubic metres per hour at 0·9 atmospheres pressure, so that either set is sufficient to operate both blast-furnaces. In addition, there are two A.E.G. 14,000-kW turbo-generators. The boiler plant consists of five tubular boilers, three of which are fitted for oil firing as a standby.

In the open-hearth steel plant nearby there is one furnace of 160 tons capacity and four of 80 tons. A mixture of blast-furnace coke oven and producer gas is used for heating the furnaces. Hot metal is brought from the blast-furnaces by a locomotive in ladles of 60 to 70 tons capacity. Scrap is obtained from a bay which extends for the full length of the melting shop and which is served by four cranes with magnets. Large ingots up to about 230 tons have been cast. Casting is done on tables, where size permits, on the group system, the small ingots being bottom poured and the large top poured. The ingots are stripped on the tables, which are then picked up by one of the cranes and the ingots are tipped on to the stocking floor. Rolling mills are situated close to the steel plant. The cogging mill is served by coal-fired furnaces. The billets are cropped by a shear in the cogging train and delivered by the crane to the live rollers serving the finishing mill, which is in parallel with the cogging mill and consists of two stands of three-high and one stand of two-high rolls. The rolled sections are sheared to length by a travelling saw in the finishing mill train.

RAILWAY LOCOMOTIVES AND WHEELS

Another interesting part of the Krupp works is that devoted to the production of railway wheels and tyres. The tyre rolling mill plant covers an area of 34,000 square yards and is equipped with three tyre mills and a wheel mill. This plant is capable of an annual production of 315,000 tyres and 120,000 wheel centres. The cylindrical billets from which the tyres are rolled are deeply nicked by cutting-off lathes with multiple parting-off tools and the resulting cheeses are cracked off by a hydraulic wedge and carried by crane to the coal-fired heating furnaces. The hot cheeses are first forged



MAIN OFFICES OF KRUPP'S ESSEN WORKS

under presses to rings of great thickness compared to the bore. In this condition they are lifted by the crane and deposited on a runway, along which they roll to the mills, where they are rolled in two stages to the finished tyre size. Treatment in a centralising press is followed by the stamping of a number or mark under a hammer.

In the early days Krupp built up a large business in the smaller kinds of locomotives, but in the redistribution of locomotive building work in Germany after the last war this work gave place to the design and construction of main line locomotives for the Reichsbahn and for countries abroad, and a special locomotive shop was built. A view of this remarkable shop is reproduced herewith. It consists of a single building having nineteen parallel bays with a total floor area of 88,800 square yards. In these shops the whole of the construction work is carried out. The central bay is reserved for erection and is served by a transfer carriage to convey the locomotives to and from the outgoing sidings to any one of the erecting tracks which run at right angles to the bay. On one side of the

building the bays are laid out for machining the mechanical parts, while on the other side the bays are equipped for the fabrication and assembly of parts of frames and tenders. The capacity of this large and well-equipped locomotive works is at least one main line locomotive each day.

FORGING PLANTS

The forging plants are numerous and serve for the production of the largest forgings for guns, naval and marine work, turbine and locomotive work, down to the small forgings required for the building of motor-cars and aircraft. They include hammer and forging shops containing over 120 steam hammers and eleven steam-hydraulic presses. The large forging press shop contains presses of 2500, 4000 and 5000 tons capacity, and one very large press of 15,000 tons capacity, a view of which we give herewith. The four columns of this steam-hydraulic press are of hollow design and the finished weight of each column is as much as 100 tons. The press is served by two 400-ton cranes for the manipulation of the ingot, and two 100-ton cranes for the handling of the tools. In addition to the big range of forging presses we have mentioned, there are drawing and flanging presses of varied capacity aggregating over 8000 tons. The rolling mills, in addition to the tyre mill already referred to, include three billet mills, a wire rod mill and two plate mills for plates and sheets, and also a mill for wheel discs.

FOUNDRIES AND MACHINE SHOPS

The steel foundries include a large shop for big steel castings and one for smaller castings, both shops being equipped with small Bessemer and electric furnaces. There are several foundries for iron, malleable iron, rustless and heat-resisting castings, and non-ferrous castings in bronze, brass and aluminium. Most of the castings receive their final finished shape in five large machine shops, all of which are provided with the latest types of machine tools. Besides the large locomotive department we have referred to, there are shops for light railway materials, wheel set shops designed to produce over 120 wheel sets and 25 locomotive wheel sets per day, and shops for sheet metal work. In four boiler shops boiler work is carried out and there are departments for springs and railway auxiliary parts. One of the firm's specialities is the production of solid forged drums for high-pressure boilers, and one of our engravings shows a view taken in this shop. We also illustrate one of the large machine shops devoted to general engineering, of which there are several. The range of work includes gun and munition production, motor lorries, oil engines, gearing and agricultural machinery, besides smaller work, such as surgical instruments, pneumatic tools, centrifugal purifiers, cash registers, "Microtest" gauges and dental work in stainless steel.

ADMINISTRATION AND RESEARCH

We give a view of the fine block of administration offices of the firm, which are situated in Thomas Strasse, in the centre of the cast steel plant and forge. Not far distant in the middle of the works stands the "Stammhaus," already mentioned in the earlier part of the article, which was the home of the Krupp family for many years. Other centres are the chemical, physical and research laboratories, which control the production of the many shops as it is going through the factory, and alongside that work there are special departments engaged in technical and scientific investigation.

Bulk Allocations to Manufacturers for Production

THE Board of Trade has issued the following announcement:—

(1) In order to reduce the number of authorisations and sub-authorisations issued, it has been decided that M forms shall no longer be required for the purchase of manufactured goods provided that the tonnage of iron and steel combined required for each individual order does not exceed 1 cwt. The present arrangement by which form M must be furnished by persons who wish to acquire, treat, use, or consume finished steel and iron castings remains unaltered.

(2) Manufacturers should apply to the Board of Trade (or for certain purposes to the Ministry of Works and Buildings—see paragraphs (11) and (12) below) for bulk allocations which they should use for the production of manufactured goods or fabricated components, not only for the purposes normally covered by the B.T.2 allocation, but also for the execution of all essential orders involving individually 1 cwt. of iron and steel or less, even though the goods are supplied to a Government Department or their contractors, or to persons who are in a position to provide form M for larger quantities.

(3) The type of bulk allocation given will depend on the nature of the goods produced. It may take the form of:—

(*a*) An undertaking by the Board of Trade to replace at the end of a stated period the tonnage of iron and steel used for approved orders; or

(*b*) A ration given at the beginning of each period to cover estimated essential requirements; or

(*c*) A combination of (*a*) and (*b*).

The Board of Trade will consider with individual manufacturers the type of allocation which is most convenient in their case.

(4) A bulk allocation must be used only for the production of the types of goods agreed with the Board of Trade. It should be used to cover:

(*a*) All orders in the execution of which 1 cwt. or less of iron and steel combined is required. This includes small orders for fabricated goods or components at present symbolised B.T.2, and also small orders which are at present symbolised by other Departments.

(*b*) Larger orders for home requirements which fall within the B.T.2 allocation. Manufacturers should sub-authorise out of their bulk allocation the iron and steel for fabricated components to be included in their own products, provided that no such authorisation is given for 1 cwt. or less.

(5) A bulk allocation should not be used:—

(*a*) For orders involving more than 1 cwt. of iron and steel if the purchaser is in a position to obtain authorisation on form M from a Government Department.

(*b*) For fabricated parts involving more than 1 cwt. of iron and steel, if they are supplied to another manufacturer as components of his products.

(*c*) For products for which bulk allocations are given by another Department, *e.g.*, ball and roller bearings and precision chains.

(*d*) For finished steel or iron castings required for the repair and maintenance of the manufacturers' own machinery, plant, and equipment, for which separate application should be made to Industrial Supplies Department, Board of Trade, Millbank, London, S.W.1.

(*e*) For iron and steel required for the repair and construction of civil building and engineering works for which application should be made to a licensing officer of the Ministry of Works and Buildings.

(*f*) For certain classes of builders' goods for which application should be made to the Ministry of Works and Buildings, Lambeth Bridge House, Albert Embankment, S.E.1—see paragraph (12) below.

(6) Manufacturers who have received a bulk allocation must, if required to do so, make regular returns to the Board of Trade showing for what purposes they have used the iron and steel which they wish to have replaced. Details of the types of return required will be discussed with the manufacturers where necessary. If it is agreed that returns shall be made, a further allocation will only be given after the returns for the previous period have been approved.

(7) Manufacturers of industrial goods are required to undertake that as far as possible they will secure that the goods they manufacture are supplied for essential purposes only. The Board are prepared to give guidance to enable a firm to decide what types of orders they should accept and to advise on doubtful cases. As they will be unable to provide sufficient steel and cast iron to satisfy all demands, they must rely upon the co-operation of manufacturers and distributors to secure that the best use in the national interest is made of the material which can be made available. Iron and steel for consumers' goods can only be provided for utility goods and only in sufficient quantities to meet minimum needs.

(8) Except as described in (4) (*a*) above, manufacturers should require their customers to furnish authorities on form M if they are in a position to do so. Much difficulty is, however, caused if manufacturers persist in asking their customers for authorisations on form M for the purposes described in (4) (*b*) instead of fulfilling these orders out of their bulk allocation, or (if they have no bulk allocation for the production of the goods required) themselves applying to the Board of Trade for the necessary authorisation.

(9) For orders covered by (4) (*a*) above, manufacturers must undertake that they will not collect authorisations on form M whatever the purpose for which the goods are supplied, and that if they receive authorisations for such orders they will regard them as invalid, and will not use them to acquire iron and steel in addition to their bulk allocation.

(10) Manufacturers who have received iron and steel on a replacement basis are warned that no replacement of the original allocation can be made except for tonnages which are accounted for under (4) (*a*) and (4) (*b*) above. If the Board of Trade decide that form M should have been obtained for the iron and steel required for the execution of a contract which has been returned as falling under (4) (*b*), they cannot replace the iron and steel, but the firm may seek authorisations from the appropriate Department either directly or through its customers. Similarly, if they consider that goods have been supplied under (4) (*a*) and (4) (*b*) for unessential purposes which cannot be justified in wartime, they cannot replace the iron and steel, and the working stocks of the firm will correspondingly be reduced. In all foreseeable circumstances, the Board of Trade will replace iron and steel used in the manufacture of machinery for which a licence has been obtained under the Machinery, Plant, and Appliance (Control) Orders, provided that the licence has not been endorsed "No steel," and that the machinery is required for purposes for which the Board are properly responsible. They will also replace the iron and steel used in the manufacture of machinery for which a licence has been granted whatever the purpose, if not more than 1 cwt. is used in the execution of each individual order.

(11) Bulk allocations will be made by the Ministry of Works and Buildings, Lambeth Bridge House, Albert Embankment, S.E.1, for certain classes of builders' goods, mainly for essential repairs and replacements. If manufacturers are in doubt whether they should

receive their allocations to cover small orders from the Board of Trade or from the Ministry of Works and Buildings, they are asked to apply to the Industrial Supplies Department of the Board of Trade. They will be informed if their application is transferred.

(12) Firms may distinguish between orders for which they must obtain authorisations from their customers and orders which fall under (4) (*b*) by referring to the booklet describing the Iron and Steel Distribution Scheme (third edition). Copies may be obtained from the Iron and Steel Control, Ashorne Hill, near Leamington Spa, Warwick. It should be noted that, in addition to the production of bricks and cement, the Ministry of Works and Buildings are now responsible for plant used in the following industries :—Roofing tiles ; agricultural drain tiles ; chalk, chalk lime, and whiting (processing plant only) ; pre-cast concrete products ; asbestos cement goods ; salt glazed stoneware ; drain pipes ; sanitary earthenware ; wall and floor glazed tiles ; gypsum (processing plant only) ; plaster board ; ready-mixed concrete ; roofing felt ; wood wool slab ; glass substitute ; sanitary fire-clay.

The Design of High-Speed Military Airplanes*

By CLARENCE L. JOHNSON†

(*Continued from page 393, December 5th*)

WEIGHT

IT is very distressing to the designer, the manufacturer, the Air Force, and finally to the taxpayer, that the trend in military aircraft design is towards higher weight, greater complication, and great complexity. It has often been stated that designs should be simplified, weights reduced, and the design considered primarily from a manufacturing point of view. Serious efforts have been made by all parties concerned to try to bring about such a trend, but it has been impossible to eliminate any of the fixed equipment or power plant items to

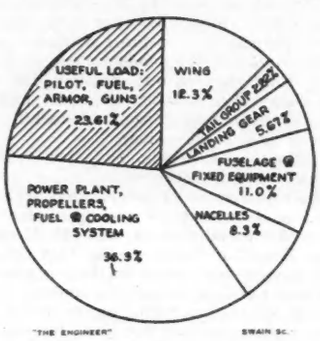


FIG. 4—*Gross Weight Breakdown of Two-engine Fighter*

obtain greater simplicity. A second best airplane cannot be tolerated in actual combat. Any means of transportation having a speed of 400 m.p.h. is inevitably complicated.

It is interesting to make a weight breakdown of a typical modern pursuit airplane. The percentage of weight over which the airplane designer has control is only 40 per cent. of the airplane gross weight ; 28 per cent. of the airplane gross weight consists of stressed material working to a very high unit stress under the design load factors (which are of the nature of 12). The remaining weight is made up of power plant and propeller, radio, instruments, tyres, wheels, armament, fuel, oil, and miscellaneous equipment. These are all items over which the airplane designer has no weight control. Figs. 4 and 5 illustrate typical breakdowns.

As airplane speeds increase, the percentage of weight in the power plant increases also. Developments in the present war have shown the need for increased equipment rather than a reduction of what is now used. It can be seen that future military airplanes will tend to become larger and more expensive as the performance is pushed up.

ENGINES

The modern high-altitude military engine is a marvellous machine when compared to other types of power generating equipment. Restricted in size, weight, fuel consumption, and cooling, it represents the most highly developed single unit of the airplane. In order to visualise the thermo-dynamic cycle and obtain an energy breakdown for a modern power plant, Fig. 3 (*ante*) has been prepared. The energy input at maximum power output at altitude for an engine of approximately 1150

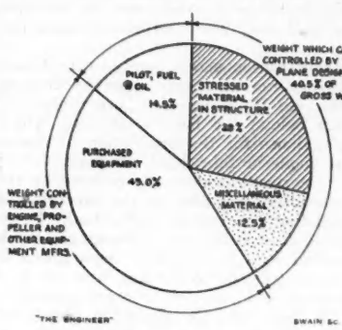


FIG. 5—*Gross Weight Breakdown of Two-engine Fighter, Showing Percentage of Weight Within Designer's Control*

H.P. amounts to 115 gallons of fuel per hour. The total energy of the fuel input amounts to 5730 H.P. Of this total power supply, a large percentage must be rejected for cooling in order to maintain satisfactory engine stresses. An additional amount is required for supercharging, cooling the oil, &c., as shown. A substantial amount of heat is rejected by radiation and oil vaporisation on the bottom of the pistons. This loss amounts to more heat than is carried away by the liquid coolant or from the finned cylinders. The largest source of energy loss is in the exhaust. At maximum power, the fuel-air ratio required to limit detonation is substantially higher than the theoretical ratio for maximum power. The excess fuel provided for this condition is present in the exhaust in

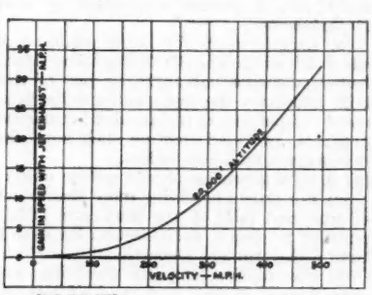


FIG. 6—*Increase in Speed Available from Simple Jet Reaction at 20,000ft. Altitude*

the partially burned state and is normally wasted. The exhaust gas leaving the cylinders has a temperature of roughly 1700 deg. Fah., and the cracking pressure of exhaust valves allows the gas to escape at pressures around 70 lb. to 90 lb. per square inch. From these figures the tremendous power loss can be understood.

A part of this power can be regained by the use of jet exhausts or a turbo-supercharger, but at the present state of development the recovery percentage has been very low. A great deal of research is being directed toward finding better ways for regaining this power. The exhaust energy can be used not only by kinetic means, but the heat energy can be applied to steam systems for power development. As speeds increase and propulsive efficiency decreases due to compressibility effects, it is not out of the realm of possibility to consider engines which furnish their power for take-off and climb to a propeller which can be feathered for level flight, and, in the latter condition, the total engine power output being used by highly developed jets for propulsion.

In order to maintain its power output at altitude, the engine is supercharged one of several ways. The most usual type of supercharger consists in a centrifugal blower geared directly to the engine with a fixed gear ratio. This same unit has been developed whereby a gear shift has been incorporated and two gear ratios are available, one for low altitude and one for high. The most advanced type of gear-driven supercharger incorporates two superchargers with an intercooling stage between the two. The third means of maintaining altitude power involves the use of the turbo-supercharger. This unit is driven by exhaust gas and maintains high power to higher altitudes than any other type of supercharging in use. Fig. 7 shows a comparison between the powers available at altitude when the above means are used for supercharging. It is apparent that the turbo-supercharger is very superior to other types at high altitudes. Difficulties in cooling, high installation drag and weight, as well as complexity in control have all hindered the adoption of turbos. Intensive research has now solved the above difficulties to the point where turbo-superchargers are reliable and easily handled items

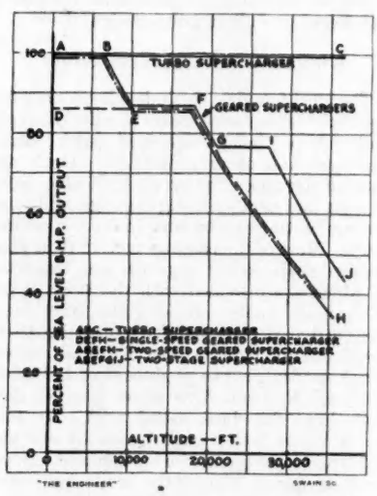


FIG. 7—*Comparison of Supercharger Types*

of equipment. The United States Army Air Corps deserves great credit for their fostering this fine development.

Most superchargers now in use in military aircraft are of the single and two-speed type. The closest approach to overall turbo performances, however, can be obtained using the two-speed, two-stage supercharger engine equipped with jet exhaust. Inasmuch as the turbo derives its power from the engine exhaust by maintaining a constant back pressure in the exhaust system, it has not as yet been found possible to obtain any substantial jet reaction in combination with the turbo-supercharger at high altitude. At low altitudes there is no reason why jet reaction cannot be obtained with the turbo operating at partial capacity. Fig. 8 shows the comparative net thrust horsepower available in an airplane equipped with the turbo supercharger in one case and the two-stage engine with jet exhaust in the other. For altitudes above approximately 20,000ft., the turbo-supercharger has better performance than its rival, but at lower altitudes present indications are that the two-stage engine with jets is superior. (See Fig. 6.)

PROPELLERS

It is becoming increasingly difficult to maintain good propulsive efficiency on military air-

* Reprinted from the *Journal of the Aeronautical Sciences*, New York, October, 1941.

† Chief Research Engineer, Lockheed Aircraft Corporation.

planes at high altitudes. Fig. 9‡ shows a summary of computed propulsive efficiency at high speeds using the best high-speed wind tunnel data available to date. While this information seems to be very pessimistic, the trend established is, no doubt, correct. The curves shown are derived from wind tunnel tests on airfoil sections subjected to two-dimensional flow. It is known that compressibility effects are less for flow in three dimensions similar to that which exists around propeller tips, and perhaps over considerable sections of

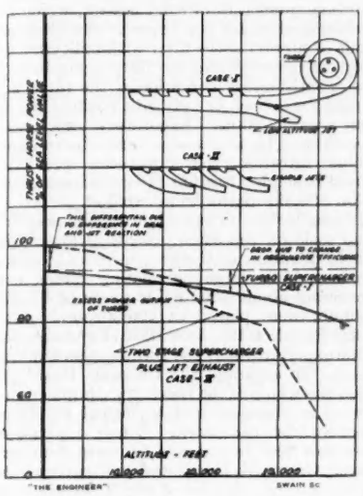


FIG. 8—*Approximate Performance Comparison of Turbo-Supercharger and Two-stage Geared Supercharger plus Simple Jet Exhaust*

the rest of the propeller. Research on propellers operating at very high forward speeds is entirely lacking in spite of the continual requests on the part of the industry for such information from the various Government agencies equipped to obtain this vital information.

There is increasing need for a gear shift to allow two engine propeller gear ratios in order to maintain proper tip speeds. The requirements for high blade area necessitates the use of an increased number of propeller blades, so

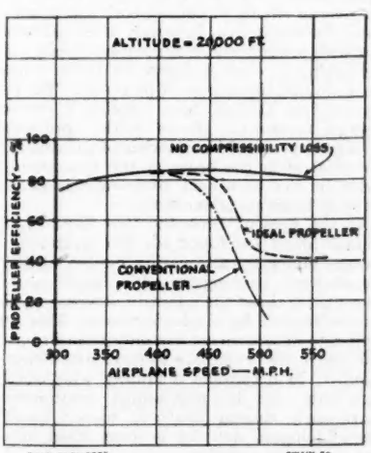


FIG. 9—*Computed Variation of Propeller Efficiency with Velocity*

the four-bladed propeller is coming into use. Tests run on counter-rotating propellers have not indicated substantial gains for the dual rotation propeller compared to the single rotation unit of the same blade area. The use of pusher propellers, desirable for many points of view when considering drag, is being retarded by practical considerations, such as the problem of landing gear wheels throwing rocks back into the blades, flutter conditions developing when wing flaps are extended, pilot escape in emergency, and the problem of ground clearance as it affects landing gear length.

At the speeds encountered with fighter airplanes, the compressibility shock wave tends to develop as quickly at the propeller hub where the sections are thicker as it does at the propeller tip where the speeds are greater. To avoid this condition, propeller hub fairings have been developed. These have not as yet proved very satisfactory except for cooling in radial engines, as the practical limitations on the chord of the fairings prevent airfoil sections of the proper thickness ratio from being used. The problem of pitch distribution also must be carefully investigated before any substantial gain in speed will result from their use. Several tests on conventional cuffs have indicated a definite speed loss when placed on an airplane in the higher performance brackets. We can expect to see a definite trend toward wider propeller blades, perhaps obtaining the aspect ratios used on the high-speed Supermarine racers in the Schneider Cup Races several years ago. The application of wide blades or wide fairings near the hub will be limited by the mechanical capabilities of the mechanisms used to obtain variable blade angles and feathering. Considerable study must be directed toward obtaining propeller sections allowing higher critical compressibility speeds.

(To be continued)

‡ "Propeller Design Problems of High-speed Airplanes," H. B. Dickinson, presented at the Airplane Design Session, Ninth Annual Meeting, I. Ae. S., New York, January 31st, 1941.

Technical Man-Power

THE Institutions of Mechanical and Electrical Engineers held a Press Conference last week in connection with problems of technical man-power. At the Conference Lord Hankey's Technical Personnel Committee was represented. Dr. Fleming represented the Engineering Advisory Committee, and there were also present representatives of the Services and of other interested bodies. Sir Noel Ashbridge, President of the Institution of Electrical Engineers, presided, supported by Mr. Stanier, President of the Institution of Mechanical Engineers. The following document explanatory of the position and of the measures that are being taken to meet the problem was issued :—

Since the outbreak of war, the Councils of the Institutions of Mechanical and Electrical Engineers have attached the greatest importance to the problem of the supply and demand of engineers for the war requirements of the Services, the Supply Departments, and industry, and in considering these problems they have always collaborated closely. The Institutions have frequently urged upon Government in the past measures to deal with this problem.

Lord Hankey is Chairman of an Inter-departmental Committee set up at the request of the Minister of Labour and National Service to deal with questions relating to the demand and supply of technical personnel of professional or approximately professional standards. His Committee, known as the Technical Personnel Committee, includes representatives of the Ministry of Labour, Service Departments, Supply Departments, Board of Trade, Ministry of Works and Buildings, and Board of Education. The Committee decided to concentrate first on the largest and most urgent need, namely, the provision of technically trained personnel for the repair and maintenance of armoured fighting vehicles, mechanised transport, artillery, searchlights, and aircraft, and for the protection of ships against mines. The Committee does not deal with the supply of radio personnel which has for some time been the concern of a Wireless Personnel Committee, also under the control of Lord Hankey. At the present time, despite the necessity for a further increase in armament production, it is imperative to ensure that there are sufficient technically trained officers to keep pace with the growing supply of equipment to the Services, so that it shall be properly maintained and repaired. Hitherto, these requirements have been comparatively modest, and have been met mostly by the Services' own resources, partly by the yearly output from the universities and technical colleges, and partly by volunteers over the age of reservation. These resources have now proved quite inadequate to the rapidly expanding needs of the Services, and the Ministry of Labour has recently announced that it has decided, on the recommendation of the Technical Personnel Committee, to review the cases of all those young engineers in civil employment with qualifications within the scope of the Joint Recruiting Boards, who were under the age of twenty-five when they registered for military service, with a view to recommending those suitable for consideration for commissions. The views of the employers of the men selected will be taken into account by a Central Allocation Committee in the Ministry of Labour, on which the Supply Departments will be represented. All holders of university degrees or higher national certificates in engineering in this age group are affected by this decision, whatever their present occupation according to the Schedule of Reserved Occupations.

It is important to consider the position of technical man-power should the war be prolonged for some years. In normal times most of the university graduates in applied science go into industry, which also absorbs, for training, considerable numbers of young men of secondary school education who acquire the requisite technical training by part-time study. It also recruits some of its technical staff from those youths who have gone into works to be trained as craftsmen but who have by diligent part-time study obtained the Ordinary National Certificate. The inflow from these sources has been sufficient in peacetime to meet wastage and expansion. During wartime much technical personnel has had to be diverted, and, in proportion to the turnover of industry, the density of technically trained personnel is much lower than in pre-war days. Then, again, during the present year the input to industry from the universities has been below normal, a situation which may well continue unless corrected. The young men from secondary schools who have ordinarily gone into industry for practical training will, as they reach recruiting age, increasingly be absorbed into the Services, so that the youths from the primary schools growing up and acquiring technical education by part-time courses of study would appear to constitute the main supply for the next few years. To ensure the maintenance of a suitable supply of technical personnel—or at any rate to minimise the loss of the more fully trained engineers—it would appear essential as a wartime expedient to establish intensive methods of training. It has now been decided that young engineers who possess the Ordinary National Certificate or comparable qualifications will be eligible for six months' full-time intensive technical training at State expense to bring them to approximately the standard of the Higher National Certificate. The effect of this will be to bring to much earlier technical maturity those who take advantage of this training.

In addition, it would appear desirable for industry to increase, as far as possible, its intake of trade and special apprentices so as to have the raw material available from which selection can be made of personnel for future courses of intensive technical training. It must be remembered that training takes time, and it would be absurd to wait until the need is acute before emergency measures are taken. As an insurance against imminent acute shortage, industry will appreciate the desirability of supporting the intensive training courses proposed.

In the meantime, efforts are being made in the Fighting Services to locate men who have already had such engineering training and experience as would fit them for promotion to commissioned rank, and, further, to select those men who have suitable basic education and practical experience to enable them to take full advantage of the intensive six months' technical training already mentioned. Meanwhile, the work of the Beveridge Committee on the Use of Skilled Men in the Services has been extended to cover officer grades to ensure

that the technical personnel already in the Services is most effectively used. Similarly, at the request of the Lord President of the Council, the Supply Departments are conducting a thorough review of the employment of technical personnel within their establishments.

SUMMARY

Briefly, therefore, the position is that the supply of engineers of professional grades for maintenance and operation requirements must keep pace with the supply of new war equipment from industry. The Services themselves are doing their utmost to comb out suitable men, and so to relieve the demand they make upon industry. In due course the output of the State Bursary Scheme which commenced last September will go far to meet the longer-term requirements arising from all quarters, but in the meantime immediate steps must be taken which will have the following form :—

(*a*) Suitable men from industry who were under twenty-five when they registered for military service will be considered for technical commissions to the Services.

(*b*) Youths withdrawn from industry at Ordinary National Certificate or Inter B.Sc. level will pass through intensive courses and will then be available for employment at Higher National Certificate level. They will be rendered suitable for up-grading by these intensive courses, and will, for the most part, return to industry.

Industry will also be asked in certain districts to make available personnel on a part-time basis to supplement teaching staffs of technical colleges.

Youths who come forward for (*b*) may rest assured that the hard work they will be called upon to perform during the course will be recognised by the award of a Higher National Certificate on successful completion of the examination, which will be assessed by the Institutions. The helpful co-operation of industry is sought so that as many young men as possible may be released for training. At the same time, every qualified engineer who volunteers and is accepted by one of the Services for a technical commission will help to reduce the number which must be withdrawn by the Ministry of Labour.

CENTRAL REGISTER

The responsibilities of the Ministry of Labour and National Service in relation to the supply and the most efficient use of professional man-power in the Services, the Supply Departments, and production are entrusted to its Central Register Branch, which has the task, not only of finding candidates for the vacancies notified to it, but also for planning the administrative measures to ensure that an adequate supply of professional man-power is forthcoming for all war purposes. The Institutions have collaborated closely with this Branch of the Ministry in carrying out its functions. The Register continues to act successfully in transferring engineering personnel from work from which they can be spared, often at some inconvenience, to work of greater national importance. The Register would be in a better position to carry out its functions if engineers would remember that they should invariably notify any change of employment or address. If there had not been a large number of omissions to supply information of this nature, the questionnaire which is now being issued to all engineers might not have been necessary. Engineers will be performing a useful service if they ensure that in future the Register is kept posted on any matters affecting the details they gave on their registration cards. The growing scarcity of engineers has now led to the setting up of the Technical Personnel Committee in order to reinforce and direct the Register in the difficult task of correlating supply and demand, and this step must be regarded as being of great importance and promise.

BRIGADIER-GENERAL SIR OSBORNE MANCE, K.B.E., has agreed to accept appointment (unpaid) as Director of Canals in the Ministry of War Transport for a temporary period.

A Month's Bombing by the R.A.F.

BRITAIN'S bombing offensive in the West continued throughout the past month on a heavy scale, despite the worst November weather conditions experienced since the war began. On one night in two, effective bombing was impracticable ; yet the tonnage of bombs delivered on German targets was nearly half as much again as in November of last year. But for the weather, it would have been much heavier still. Eighteen targets in Germany itself were attacked—the biggest attacks being on Hamburg and Emden, which had three raids each. Berlin was visited once ; so were Bremen, Bremerhaven, Cologne, Cuxhaven, Dusseldorf, Lubeck, and Mannheim. Essen and Kiel were attacked twice each during the month. German targets in occupied territories were also heavily attacked. Places visited included Dunkirk (seven times), Ostend (six), Boulogne and Brest (four each), Cherbourg (three), Le Havre, Calais, and Berck (twice each) ; altogether, thirty-eight targets were attacked in enemy-occupied territory in the west. In addition, there have been the big offensive operations in Libya.

Much of the credit for sustaining the air offensive against the enemy in Europe in the face of difficult weather conditions and increasing opposition is due to the big new aircraft now operating with the R.A.F. bomber fleets. The heavy bomber of the Short "Stirling" and Handley Page "Halifax" type has shown a distinct superiority over the earlier two-motor types when operating in bad weather conditions. It has also proved markedly superior in penetrating the enemy's defences, and especially in combat with enemy fighters. Apart from the advantages of carrying a greater load for each unit operating, with a consequent saving in the numbers of personnel engaged for an equal weight of bombs carried, the greater speed and heavier defensive armament has resulted in a reduction in the inevitable margin of aircraft lost in action. The percentage of new big bombers lost on night raids has proved appreciably lower than that suffered by the earlier two-motor types, even when operating under identical conditions. Britain's decision to develop the bomber along the lines of greater size with load capacity, allied with high defensive qualities and as much speed as may be possible, is to some extent shared by America. The enemy's own choice, so far revealed, still seems to be in the direction of speed with comparatively light armament. Apart from the commerce-raiding Focke Wulf, no new big four-motor types have yet appeared in the west. None the less, the Nazis have learnt something from the R.A.F. about defensive armament on their bombers since the days of the Battle of Britain. Like an earlier decision, the adoption by the R.A.F. of the eight-gun fighter, the decision to develop the big bomber was made in pre-war days. The grim experience of actual war conditions was not available to prove the decision right or wrong. In the event, both decisions have, it is claimed in authoritative circles, been proved to be right.

Treatment of Sewage and Trade Effluents*

BY the usual method of treatment of sewage in percolating filters at sewage disposal works the sewage is first passed through screens and tanks to remove most of the solid matter. The settled liquid is then passed through a percolating filter over which the liquid is distributed through suitable stationary jets, or by means of moving sprinklers. Some years ago the Water Pollution Research Board were faced with the problem of devising a satisfactory method of purifying the polluting waste washing waters from milk collecting and distributing depôts and from the manufacture of cheese, butter and other milk products. Among the methods tried for purifying these waste waters was that of treatment by single filtration according to the process ordinarily employed for domestic sewage. Satisfactory purification was obtained for a time, but the quantity of solid matter, including growths of fungi and other organisms, which formed in the top layers of the filter soon clogged the filter. In experiments in the laboratories of the Birmingham Tame and Rea District Drainage Board it was discovered that excessive quantities of solid matter, which had accumulated in the top layer of the filter as a result of supplying the filter with milk effluents, could be removed and the filter again brought into a satisfactory condition if the filter were treated for a week or two with purified effluent from another filter. Laboratory experiments showed that by this new process of alternating double filtration the difficulties previously caused in single filtration by excessive accumulation of solid matter were avoided.

It was decided to carry out experiments on a large scale on the same process of alternating double filtration in the treatment of domestic sewage. Four large percolating filters, each containing about 2300 cubic yards of filtering medium, were placed at the disposal of the Water Pollution Research Board for the purpose of the experiments by the Birmingham Drainage Board. In addition, the Drainage Board provided the whole of the necessary equipment and erected a chemical and biological laboratory specially for the work. These experiments have now been in progress for more than three years. One of the large filters has been operated by the normal process of single filtration and two have been operated by the process of alternating double filtration, using sewage liquor from the same source. It has now definitely been established that by the new process the quantity of sewage liquor which can be efficiently purified by alternating double filtration is twice as great per cubic yard of filtering medium as that which can be efficiently purified by single filtration. This result at once shows how the capacity of existing percolating filters at sewage disposal works can be doubled. In changing over from the old process to the new process it is necessary to install additional tanks to remove solid matter from the effluent from the primary filter before this liquor is supplied to the secondary filter. It is also necessary to install pumps to pump the settled liquid from one filter to the other filter. The net overall saving in capital cost and in materials of construction, however, is considerable, and with sewage works of medium or large size the saving in capital charges is much greater than the additional cost of pumping. The new process has already been applied in several sewage treatment plants with appreciable savings in cost and in materials of construction. The change in the order of the two filters in series in the treatment of sewage is usually made at intervals of one week.

At the present time the two large experimental filters employed for the treatment of sewage liquor by alternating double filtration are efficiently treating per cubic yard of medium about three times the quantity of sewage which can be treated by single filtration. This very high rate of treatment has only been in operation for a few months. Further experience is required to determine definitely whether this high rate can be maintained continuously, particularly during the cold winter months, when biological activity is lower than during warm summer months.

* Institution of Chemical Engineers and Chemical Engineering Group of Society of Chemical Industry, December 9th, 1941, by Dr. A. Parker.—Extracts and Summary.

CAN PLASTICS REPLACE METAL ?—Discussing this problem in an American contemporary recently, Mr. H. Chase argued that in a normal economy plastics can take the place of metals only where they provide either a product of lower cost or a balance of advantages not realised more cheaply by some other means. "In a defence economy, certain artificial factors enter to change the picture, but in the long run plastics are likely to be chosen only for those applications in which their inherent qualities make them cheaper or better for a given purpose."

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Japan's Metal Position

The outbreak of hostilities in the Far East by Japan's attack upon the United States and Great Britain is likely to have considerable influence upon certain markets, more especially the tin market. Malaya is the world's largest tin producer, and in 1940 produced 85,384 tons out of a total world production of 237,600 tons. Fortunately, good stocks of tin, it is believed, are held in the United States and in this country, but the disturbance to communications by war operations may make it necessary to draw upon these supplies. At the same time, the operations of the tin smelters in the East may be seriously interfered with. Since Japan adopted a threatening attitude, the tin market has been under the influence of the various diplomatic moves that have been made, and when the position has appeared serious, has quickly reflected by an advance in prices the feeling of consumers in this country and in the United States. Now that the Japanese Government have decided on war and the worst is known, the effect upon the market may not be so serious as was feared, but much, of course, will depend upon the developments of the war. From other points of view, Japan would not appear to be in a good position as regards metals for the conduct of a long struggle. Last October, it is pointed out in the *Foreign Commerce Weekly*, the organ of the United States Department of Commerce, the sale of fifty-six commodities, chiefly those made of iron, steel, and copper, was prohibited as part of a movement for the special collection of metal products. During the past year a number of Orders have been issued restricting transactions in copper and gold ore. At the same time the Japanese Government has initiated a shipbuilding programme, and in October shipbuilders were pressing for additional allotments of materials, labour, and electric power for their dockyards and subsidies for the encouragement of ship construction. It was also reported that the Japanese Government had agreed to guarantee by 100 per cent. loans extended by the Industrial Bank of Japan to finance ship construction, and to speed up construction on a mass-production basis. The Japanese have made great efforts to encourage the establishment of a prosperous iron and steel industry, which have not been without some success. The latest statistics show that in 1936 Japanese blast-furnaces produced 2,868,860 tons of pig iron and in the previous year 57,818 tons of ferro-alloys. The Japanese production of steel ingots in 1936 amounted to 5,258,119 tons and 109,788 tons of castings, whilst the production of finished steel in 1936 amounted to 4,351,589 tons.

The Pig Iron Market

Perhaps the most interesting movement in the iron and steel markets has been the report that the system of rebates will be suspended for the duration of the war. Under this scheme all consumers of British pig iron received a rebate of 5s. per ton upon their undertaking to use only home-produced material. Naturally, at a time when the Continent, the chief competitor of the British pig iron makers, has been eliminated by war developments from the British market and such foreign pig iron as is distributed to consumers is done by a Government Department, the scheme had little point. Nevertheless, it will be welcomed by users all over the country and is a simplification of trading methods and a move which will save time and labour. The general position in Great Britain has not altered and may be considered satisfactory. The raw materials position is comfortable. Production of home-produced ore is being pressed to the utmost and a larger proportion is being used than at any time since the war began. At the same time, it is understood that stocks of both domestic and imported ores are considerable. Supplies of high-phosphoric foundry iron are more than adequate to meet the demand, and it is reported that stocks of pig iron have accumulated at the Midland blast-furnaces. Low-phosphoric iron is not in such plentiful supply, but sufficient is being produced to meet current requirements. The Control arrangements provide that Scottish consumers and users on the North-East Coast receive their requirements of foundry iron from the Midlands, and in the latter area little Cleveland foundry is being manufactured as blast-furnaces are concentrating on the production of pig iron for the steel works. Ample supplies of basic iron are available for the manufacture of steel, and although the distribution of hematite is carefully watched over by the Control the position is only moderately tight. Consumers, however, must use other descriptions of pig iron wherever possible, since, with the reduction of imports from the United States, Great Britain is thrown upon her own productive resources in the case of this pig iron, plus stocks which the Control has managed to accumulate. If these were freely distributed a stringency might develop and it is this that the Control is carefully guarding against.

The Midlands and South Wales

Steel production in the Midlands continues at a high rate, and as the raw materials position is satisfactory the industry looks forward to a long period of great activity. Constructional engineers in the Midlands are not overburdened with work, and as a result the demand for heavy joists and sections is not pressing. The majority of the works producing this material are moderately well employed, but are in a position to accept fresh business if it was forthcoming. On the other hand, there is a steady stream of orders for lighter structural material reaching the mills and the demand in this direction shows a tendency to increase. Little change has occurred in the plate position. The requirements of the shipbuilding industry and tank makers show no signs of decreasing and the pressure of the demand is testing the resources of the works producing plates; by pressing outputs to the limit, however, the manufacturers have been able to maintain reasonable delivery periods. Sheet works are well employed, although they are not experiencing the same heavy pressure of orders that characterised this industry a month or two ago. Many of the works are in a position to accept additional business and lately there has been a fair amount of buying on the part of stockholders. Most of the work in the hands of the manufacturers, however, is for the Government and comes within the priority classes. The demand for alloy and special steels is maintained at a high rate and the pressure upon all works producing this class of material is severe, in spite of additional plant having been put into operation to increase the output of these steels. There is a brisk request from the collieries for steel for maintenance purposes, but the position is not difficult. An active demand exists for bright-drawn bars and cold-rolled strip, which the makers find difficult to satisfy. In South Wales there is some variation in the activity at the steel works. Those engaged in producing steel for the essential war industries are fully employed, but others which are occupied with less urgently required material could accept more orders. There is a heavy production of billets, but the output of sheet and tinplate bars has slackened somewhat, as the tinplate industry is not well employed, as a result of the Government's restrictions on export business. There is rather more activity noticeable in the sheet trade, but all the mills are not fully engaged.

The North-East Coast and Yorkshire

There is a strong and continuous pressure from consumers engaged on war work to obtain supplies of finished steel. In a few departments there has been some slowing down in activity, but in the majority of cases the demand is fully maintained or on an increasing scale. The speed-up at the munition works has naturally resulted in greater activity at the steel works and although production is kept at capacity, the industry on the North-East Coast is taxed to the limit to maintain its present satisfactory rate of delivery. Naturally, the very drastic limitation of the use of steel products to urgent war needs has had some effect in reducing the call upon some of the finishing departments, but this is only relative and the effect is scarcely noticeable. The re-rolling industry is in a position to accept fresh orders and to give earlier delivery than a few weeks ago. Their reserves of semis are being drawn upon, but there is no real stringency in supplies, although consumers have to rely upon home-produced billets and sheet bars. There is a steady call for small bars and strip, which seems to be gradually expanding. The works producing heavy joists and sections are quiet by contrast with the remainder of the industry, and although a short time ago a revival in the demand for this class of material was forecast, it has not yet developed. On the other hand, all the plate mills are fully employed and there is a big demand, particularly from the tank makers and shipyards. Large tonnages of plates are being absorbed and the full production goes immediately into use. The request for colliery steel remains active, although busy conditions have prevailed in this department for many months, whilst there is an active business passing in miscellaneous products for the railways. The Yorkshire steel industry is fully employed, chiefly upon priority work. The basic steel plants at Sheffield are fully occupied, whilst producers of acid carbon steel are kept actively engaged upon Government orders. The makers have full order books in both these departments, but the sustained demand prevents any reduction of the work in hand. There is a drive to increase production of alloy and special steels and new furnaces are continually being put into operation. Although production is at a high level, the Control is carefully supervising distribution and the position has to be watched. High-speed steels are in vigorous request and the makers are kept fully employed.

Non-ferrous Metals

The fear of war in the Pacific has overhung the metal markets for several months, but it has had less influence on the copper market than the tin market. The American embargo upon copper shipments to Japan has been in force for some time and it is difficult to see from what source Japan can draw the supplies she will require in a war of the first magnitude. The possibility of raiders interrupting the transport of copper from South America to the United States may be taken into account, but such an interruption is not likely to be more than intermittent. The war in the Pacific may affect communications with Australia and Great Britain, but it is from countries much further west and in all probability outside the orbit of Japanese operations that the greater part of our supplies of copper, lead and spelter come. It is understood that the Control is comfortably situated and there seems no likelihood that the war industries will suffer from any shortage of copper. Large quantities are, of course, being used in the manufacture of munitions. . . . The outbreak of hostilities in the Pacific has had more effect upon the tin market than any other. Japan's treacherous attack on the United States, occurring on a Sunday evening, afforded a little time for the metal trades to consider the position, and when the market met on Monday morning it was far less excited than might have been expected. The price rose 30s. to 35s. compared with the closing prices of Friday, but the possibility of a runaway market seemed less likely after the first few dealings than had appeared probable before dealings began. The authorities, however, probably expected that with the possibility of interruptions in communications from the countries of production the price might get out of hand and, after dealings had been in force a few minutes, an Order was announced bringing the market under control, in the same way that other non-ferrous metals are controlled. The Metal Exchange therefore made a settlement price and the proceedings closed. It is understood that large stocks of tin are held in the United States and that the position in this country is satisfactory. . . . The lead situation remains unaltered and although the Control continues carefully to supervise the distribution of the metal, the position is considered satisfactory. The development of the war in the Pacific may interfere at times with supplies, but good stocks of lead exist in this country. In the United States the position is tight, but the firms engaged on war production are getting all the metal they require. . . . The spelter position remains stringent and little metal is released for non-essential work. Japan is understood to have made efforts to accumulate stocks of spelter during the past year or two, but she has probably already been forced to draw upon these supplies. Firms engaged in the British war effort are getting the spelter they require with regularity.

Control of Tin Order

The Minister of Supply has made the Control of Tin (No. 3) Order, 1941, which came into force on December 9th. Under this Order any person holding any tin in the form of ingot, slab, block, bar, stick, grain tin or granulated tin, other than a person carrying on an undertaking which involves the treatment or use consumption of such tin, is required to hold that tin at the disposal of the Minister of Supply and to send forthwith particulars of quantities, qualities and location of his holding to the Joint Controllers of Non-ferrous Metals. This requirement applies both to tin situated in the United Kingdom and to any tin which subsequently arrives in or is produced in the United Kingdom. Further, as from the date when the Order came into force, no person can acquire any tin in the above forms or tin scrap, ore tin concentrate, residue, slag, dross or sludge without a licence from the Minister, or dispose of such material unless to the holder of a licence. All communications should be addressed to the Joint Controllers of Non-ferrous Metals, Grand Hotel, Rugby. Copies of the Order may be obtained, in due course, from H.M. Stationery Office, York House, Kingsway, W.C.2, or from any bookseller.

Notes and Memoranda

Rail and Road

SOUTH AFRICAN RETURNS.—The six months' earnings of the South African Railways and Harbours for the period April to September have risen from 18½ million pounds to more than 20½ million pounds.

THE C.N.R. AND THE WAR.—The 1942 programme of the Canadian National Railways will be the "biggest yet." The company's purchases for the year may amount to 100,000,000 dollars, much of which is to cover expansion, including new yards and shops, extended sidings and new equipment.

INDIAN RAILWAYS TO PASS TO THE GOVERNMENT.—The Government of India has decided to exercise an option to determine the contracts of the Bengal and North-Western and the Rohilkund and Kumaon Railway Companies on December 31st, 1942, and thereafter to undertake their working. Under the contracts the Government had the option of purchasing these railways either at the end of 1937 or at the end of 1942. Otherwise the railways were to remain private property for another forty years.

WORK TO PROCEED.—The Argentine Government has authorised the State Railway Department to resume work on the construction of the uncompleted portion of the Argentine section of the projected international railway between Salta, Argentina, and Socompa on the Chilean frontier, which has been suspended for several years. The financial provisions cover five years, by which time it is estimated that the entire work should be finished. The Department is authorised to arrange for the purchase of 100 kiloms. of rails and other track materials for delivery, if possible, during 1942.

TO PROVIDE FOR DEFENCE.—Some idea of the part railways are playing in the U.S.A. defence programme was disclosed recently by Colonel L. R. Groves, Chief of the Operations Branch of the U.S.A. Quartermaster-General's Construction Division. To date some 1356 miles of new railways have been required to serve the new ordnance plants completed or under construction in various parts of the States. In addition, at least 1000 miles of new highways have been built. An outstanding example was the need of the Ravenna Ordnance plant in Ohio, for which 123 miles of new railway had to be laid.

NOT MANY LOCOMOTIVES CAPTURED.—According to American advices, the Germans have had to find a good deal of rolling stock for use on the captured Soviet railways, as only relatively small numbers of Soviet locomotives and goods vehicles have fallen into the hands of the German Army. In order to establish through traffic the Germans have converted the 5ft. gauge of the Russian railways to the European standard of 4ft. 8½in. by moving one of the rails and replacing the points. Up to a point this has been accomplished successfully, but the large number of bridges blown up by the retiring Russian forces continues to hamper railway transport in the occupied territories.

Air and Water

NEW INSTRUMENT FOR SANITARIANS.—An instrument to record the dissolved oxygen level continuously in sewage treatment processes was described at a recent meeting of the American Chemical Society. Variations in the dissolved oxygen, measured by a dropping mercury electrode, produced changes in the current flow which were amplified and recorded upon a thread galvanometer for twenty-four-hour periods.

POWER FOR MERCHANT SHIPS.—The General Electric Company of America has embarked on a scheme for the construction of two new plants for the manufacture of propulsion equipment for merchant ships. The plants will be financed by the Defense Plant Corporation under a lease agreement to the extent of between 20,000,000 and 25,000,000 dollars. The larger, for manufacture of turbines, will be at Erie, Pa.; the other, at which reduction gears will be made, will be at Lynn, Mass. The company has also announced plans for the construction of a 20,000,000-dollar factory at Fort Wayne, Ind., for the manufacture of turbo superchargers for aeroplanes, now being carried on at Lynn, Mass.

CAN SOUTH AFRICA BUILD SHIPS?—The S.A. Board of Trade and Industries has visited Durban to investigate the practicability of establishing a shipbuilding industry in the Union. The field of the inquiry is far-reaching and will have particular reference to the supply of raw materials, the ability of a South African industry, if established, to compete with shipbuilding yards elsewhere, not only during prosperous times, but in periods of international trade depression; the availability of the necessary skilled and other labour; the possibility of establishing such an industry without financial or other assistance from the Government; the disposal of Union-built vessels; and the possible influence that the cost of such vessels may have on the cost of marine transport to and from the Union.

Miscellanea

GRAPHITE IN LABRADOR.—Graphite with a purity up to 80 per cent. has been found at Saglek Bay, Labrador. Steps have been initiated to ensure commercial production.

NEEDLE FACTORIES IN CHINA.—One of the surprising things about this war is the changes made in the distribution of industries. Since 1937, when China began needle making on modern lines, no fewer than five plants have been installed in or near Shanghai. The outputs are high and are likely to injure permanently Germany's sales in the Far East.

INSTITUTION OF NAVAL ARCHITECTS.—An extraordinary general meeting of the Institution of Naval Architects was held at the Connaught Rooms, London, on Wednesday, December 10th, when Sir Eustace H. T. d'Eyncourt presided. The sole purpose of the meeting was to elect Admiral of the Fleet, the Right Hon. Lord Chatfield, as President of the Institution, in succession to the late Lord Stonehaven. A luncheon followed the meeting and was attended by a large company of members and guests. Lord Chatfield presided, and in the unavoidable absence of the Right Hon. A. V. Alexander, First Lord of the Admiralty, the toast of "The Institution" was proposed by Lord Hankey, Chairman of the Engineering and Scientific Advisory Committees. After referring with regret to the loss of H.M.S. "Prince of Wales" and H.M.S. "Repulse," Lord Hankey congratulated the Institution on its choice of President, and paid tribute to the assistance given by the Royal Corps of Naval Constructors to the two Committees over which he presided. The toast was acknowledged by the President, whose health was then proposed by Sir Eustace H. T. d'Eyncourt.

HOURS OF WORK IN THE BUILDING AND CIVIL ENGINEERING CONTRACTING INDUSTRIES.—The hours of work recently permitted in the building and civil engineering contracting industries provided for a maximum week of sixty hours on weekdays and no Sunday work save in certain exceptional circumstances. In winter the limited hours of daylight permit a maximum of only forty-four hours if work on Sundays is not allowed, and it has been represented to the Government that, in view of the urgent necessity for maintaining production at the highest possible level, Sunday work should be allowed until such time as more than fifty hours per week can be worked in daylight without recourse to Sunday working. The Minister of Labour and National Service and the Minister of Works, in consultation with the representatives of employers and workers, have therefore decided that hours should be so adjusted as to permit of an average of fifty per week being worked until the beginning of February and for this purpose the following Sundays should be worked:—December 14th, 1941, December 21st, 1941, January 4th, 1942, January 18th, 1942, February 1st, 1942. The Ministers hope that in all building and civil engineering contracting work connected with the Government building programme, or otherwise of vital importance, full advantage will be taken of these hours. Sundays are excluded from the calculation of the guaranteed week under the Essential Work (Building and Civil Engineering) Order, and workmen on scheduled sites are entitled to their guaranteed minimum under the Order irrespective of any work done on Sunday.

Personal and Business

THE MINISTER OF SUPPLY has appointed Mr. R. O. Herford to be Controller of Inspection (Administration) in the Ministry.

DR. E. W. MARCHANT is shortly retiring from the David Jardine Chair of Electrical Engineering, Liverpool University.

MR. W. FINLAY has been elected Chairman, and Mr. V. Watlington Vice-Chairman, of the Electrical Fair Trading Council.

THE MINISTER OF SUPPLY has appointed Mr. R. L. Prain, Deputy Controller of Diamond Dies, to be Controller of Diamond Dies and Tools. All communications should be addressed to the Controller at 2, Horton Crescent, Rugby (telephone, Rugby 3315).

MR. E. BRUCE BALL, jun., M.A. (Cantab.), M.I. Mech. E., has been appointed joint managing director of Glenfield and Kennedy, Ltd.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Fuel Luncheon Club

Friday, Dec. 19th.—Connaught Rooms, Great Queen Street, W.C.2. Luncheon. "Fuel: The Wide Aspect," C. H. Lander. 12.40 for 1.10 p.m.

Institute of Estimators, Planning, and Time Study Engineers

Sunday, Dec. 14th.—Waldorf Hotel, Aldwych, W.C.2. "Estimating," W. L. Morgan. 2.30 p.m.

Institute of Transport

Saturday, Dec. 13th.—METROPOLITAN GRADUATES: Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Air Raid Precautions for Goods Road Transport," N. W. Sharratt. 2.15 p.m.

Institution of Automobile Engineers

Sunday, Dec. 14th.—LONDON GRADUATES: 12, Hobart Place, S.W.1. "Design Department," J. B. Perrett. 2.30 p.m.

Institution of Civil Engineers

Tuesday, Dec. 16th.—College of Technology, Sackville Street, Manchester. Joint discussion on "The Efficient Use of Fuel." 2.30 p.m.

Institution of Electrical Engineers

Saturday, Dec. 13th.—N. MIDLAND CENTRE: Hotel Metropole, King Street, Leeds. "Metal Rectifiers," A. L. Williams and L. E. Thompson. 2.30 p.m.

Thursday, Dec. 18th.—Savoy Place, Victoria Embankment, W.C.2. "Voice-frequency Signalling and Dialling in Long-distance Telephony," W. G. Radley and E. P. G. Wright. 5 p.m.

Friday, Dec. 19th.—N.E. STUDENTS: Neville Hall, Westgate Road, Newcastle-upon-Tyne. Address, R. W. Gregory. 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Dec. 16th.—39, Elmbank Crescent, Glasgow. "Influence of the Shape of Blade Sections on Singing of Propellers," G. Hughes. 6.30 p.m.

Institution of Mechanical Engineers

Saturday, Dec. 13th.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester. "A Century of Tunnelling," W. T. Halcrow. 2.30 p.m.

Tuesday, Dec. 16th.—Storey's Gate, Westminster, S.W.1. Joint meeting with Inst. C.E. "Balance of Locomotive Reciprocating Parts," E. S. COX; and "Hammer Blow in Locomotives: Can It Not be Abolished Altogether?" Sir H. N. Colam and J. D. Watson. 2.30 p.m.

Friday, Dec. 19th.—Storey's Gate, Westminster, S.W.1. "Axial Vibration of Diesel Engine Crankshafts," R. Poole. 2.30 p.m.

Institution of Production Engineers

To-day, Dec. 12th.—N.E. SECTION: County Hotel, Newcastle-upon-Tyne. "Drop Forgings," A. Chilton. 6.15 p.m.—LONDON SECTION: Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. "Sampling Inspection and Quality Control," B. P. Dudding. 3 p.m.

Iron and Steel Institute

Monday, Dec. 15th.—Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. "The Practical Side of Blast-furnace Management, with Special Reference to South African Conditions," R. R. F. Walton. 6.30 p.m.

Junior Institution of Engineers

Saturday, Dec. 13th.—39, Victoria Street, S.W.1. Presentation of awards and induction of Lord Sempill as President. 2.30 p.m.

Manchester Association of Engineers

Saturday, Dec. 13th.—Engineers' Club, Albert Square, Manchester. "The Manufacture of Articles from Powdered Metals," W. D. Jones. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Dec. 12th.—Mining Institute, Newcastle-upon-Tyne. "Plastics and Engineering," A. Caress. 6 p.m.

Wednesday, Dec. 17th.—STUDENT SECTION: Bolbec Hall, Newcastle-upon-Tyne. "Turbo-blowers," W. T. Atkinson. 6.45 p.m.

North of England Institute of Mining and Mechanical Engineers

Saturday, Dec. 13th.—Neville Hall, Newcastle-upon-Tyne. "General Management of Pit Ponies," F. Christopher. 2 p.m.

Royal Society of Arts

To-day, Dec. 12th.—John Adam Street, Adelphi, W.C.2. "Facilities for the Technical Training of Artisans and Craftsmen in India," A. T. Weston. 1.45 p.m.